DOCUMENT RESUME

ED 038 239 08 RE 002 383

AUTHOR	Gotkin, Lassar G.; And Others
TITLE	The Development of a Beginning Reading Program: An Empirically Derived Sequence for the Acquisition of Analytical Skills. Final Report.
INSTITUTION	New York Univ., N.Y. Inst. for Developmental Studies.
SPONS AGENCY	Office of Education (DHEW), Washington, D.C. Bureau of Research.
BUREAU NO	BR-5-0749
PUB DATE	Jun 69
CONTRACT	OEC-5-85-013
NOTE	214p.
EDRS PRICE	EDRS Price MF-$1.00 HC-$10.80
DESCRIPTORS	*Beginning Reading, Behavioral Objectives, *Culturally Disadvantaged, Educational Strategies, *Kindergarten Children, *Learning Motivation, *Multimedia Instruction, Reading Research, Sequential Reading Programs, Transfer of Training

ABSTRACT

A 3-year Harlem project in which 5-year-olds from socially disadvantaged backgrounds were taught an interrelated hierarchy of beginning reading skills utilizing the Edison Responsive Environments instrument (talking typewriter) was reported. The investigation differed from O. K. Moore's approach in three ways: (1) parsimonious use of instructional time and machines, (2) concern with developing a reproducible set of instructional events rather than individualized programing, and (3) a strong emphasis on engineering an attentional environment rather than a discovery environment. Consequently, emphasis was on development of instructional, behavioral, and motivational strategies. Tutorial strategies were designed to facilitate adapting lesson sequence to nonmechanical or nontechnological modalities. Reading skills are presented in detail as behavioral objectives and programing paradigms related to teaching these skills are described. Two validation studies and a transfer study are reported. Charts, tables, and references are included. (WB)

BR 5-0749
PA 08
RE

Institute for Developmental Studies
School of Education
New York University

ED0 38239

THE DEVELOPMENT OF A BEGINNING READING PROGRAM

An Empirically Derived Sequence for the Acquisition of Analytical Skills

by

Lassar G. Gotkin, Ed.D.
Joseph F. McSweeney
Ellis Richardson

U.S. DEPARTMENT OF HEALTH, EDUCATION & WELFARE
OFFICE OF EDUCATION
THIS DOCUMENT HAS BEEN REPRODUCED EXACTLY AS RECEIVED FROM THE PERSON OR ORGANIZATION ORIGINATING IT. POINTS OF VIEW OR OPINIONS STATED DO NOT NECESSARILY REPRESENT OFFICIAL OFFICE OF EDUCATION POSITION OR POLICY.

June 1969

RE 002 383

Final Report to the Office of Education
Department of Health, Education and Welfare
Washington, D.C. 20201

Research Project No. OE-5-85-13:
Development of a Reading Skills Program

ED0 38239

INSTITUTE FOR DEVELOPMENTAL STUDIES
School of Education, New York University
Washington Square, New York, New York 10003

THE DEVELOPMENT OF A BEGINNING READING PROGRAM

An Empirically Derived Sequence for the Acquisition of Analytical Skills

by

Lassar G. Gotkin, Ed.D.
Joseph F. McSweeney
Ellis Richardson

Illustrations by
Thomas McKinney

Manuscript coordinator
Linda Barry

June 1969

Preface

> Man was not born to solve the problems
> of the universe, but to put his finger
> on the problem and then to keep within
> the limits of the comprehensible. (Goethe)

The research project described in this report was not designed to solve the problems of the universe. It did involve, however, pointing to the very important problem of the acquisition of beginning reading skills. Throughout, a clear attempt was made to keep within the limits of the comprehensible and achievable.

For three years a reading research laboratory was conducted in a Harlem school. The research conducted in that laboratory touches on a variety of practical and theoretical issues related to beginning reading instruction, the use of complex instructional technology, and the learning abilities of young children from disadvantaged backgrounds. From the outset it was made clear to the school personnel that ours was a research rather than a service project. To have such a project run in such a setting and to have it run smoothly requires the cooperation of a great many people ranging from the principal to the custodial staff. This project could not have been successful without that cooperation.

The need for such cooperation becomes even more clearly understood when one recognizes that the school was the center of several major community and staff upheavals during the conduct of the study.

Mr. Stanley Lisser, Mr. Harvey Nagler, and Mr. LeRoy Watkins, Principals of P.S. 175 during that period, all cooperated in ways to facilitate the project's success. Mr. McBride and his custodial staff were also most helpful.

On a day-to-day basis, the kindergarten teachers, especially Mrs. Margaret Holley, were essential to the work. Their flexibility was critical in enabling children to leave class for their daily lessons without upsetting the children or their classroom routines.

We owe a debt to the Responsive Environments Corporation for prompt service and modifications of the equipment which was used.

During the first year of the project, Miss Fairfid Caudle and Mrs. Jacqueline Stuchin contributed to shaping the direction of the study.

Our two paraprofessionals, Miss Caroline Kelly and Miss Jacqueline Thomas proved both reliable and competent in keeping records, working with the children and even programming the machines. During the latter stages of the project they both did some individual tutoring of children as a service to the school. Mr. Thomas McKinney was added to the staff in 1967. His imagination in implementing the art work of lessons took us from a crude stage to a very professional one in our lesson production.

The final writing of the report was complicated by our own new involvements which came at the very end of the project. Miss Linda Barry and Mrs. Mary Eisman of the Institute for Developmental Studies made very real contributions in the coordination and editing of the report. Finally much administrative support came from the staff of I.D.S. We are particularly indebted to Mrs. Fay Boulware for her patient and efficient management of project business. A special acknowledgement is due to Dr. Martin Deutsch for providing the environment in which the creative efforts of the project staff could flourish.

A word about the way the final report was written. Each chapter was written to stand on its own as much as possible. For each chapter, one of us took principal responsibility for the writing. In the Table of Contents, that person is identified as the principal author of the chapter. With the exception of Appendixes C and D, the names of associates, who are co-authors, are omitted because it just seemed redundant to present three names in mixed order again and again.

June, 1969

Lassar G. Gotkin, Ed.D.
Joseph F. McSweeney
Ellis Richardson

Table of Contents

Chapter Page

I Introduction (Gotkin) 1

II The Setting and Apparatus (McSweeney).......................... 11

III The Instructional Program and Its Development (McSweeney)....... 15

IV Instructional Strategies (McSweeney)........................... 36

V Validation Study (McSweeney)................................ 55

VI Facilitation of the Acquisition of Phonic Elements Through the Application of Learned Behavioral Structures (Richardson)... 68

VII Summary, Significance, and Implications (Gotkin)................ 79

Appendix

A Developmental History and Testing of the Program (McSweeney).... 96

B The Criterion Test (Richardson)................................ 124

C Basic Research (Richardson and McSweeney)...................... 131

D Program Skill Objectives, Content Sequencing, and Behavioral Structures (McSweeney and Richardson)............... 138

E A Report on Machine Failures and Down Time for a Six-Month Period (Richardson)................................ 150

F Acquisition of Pre-reading Skills using a "Talking Typewriter": a dialogue (Gotkin)................................ 152

Chapter 1. Introduction

This report describes a three-year project in which five-year old children from socially disadvantaged backgrounds were taught an interrelated hierarchy of beginning reading skills. This research constitutes one of the most detailed studies of its kind. First, by working with children from disadvantaged backgrounds and by carefully pretesting, we were dealing with children who had little or no prior knowledge of the reading skills being taught. Second, by using children individually in controlled settings, we could more nearly identify, isolate, and control the events that constitute the instructional sequences. Third, while the instruction was limited to less than ten hours, ten hours represents a far longer period of time than that involved in most controlled learning experiments.

This introductory chapter provides an overview of the entire project by describing the contents of each chapter. An attempt has been made in writing each chapter to have it stand on its own. Although it is possible to read chapters independently of the entire report, we do recommend that they be read in order.

A. The Setting and the Apparatus (Chapter II)

This chapter describes the laboratory setting in which the research took place and the capabilities of the instrumentation which served as a major component of the research.

Some difficulty in explaining the work of this project is related to the particular piece of equipment we have used, the Edison Responsive

Environments instrument, also known as the Talking Typewriter. This instrument is engineered around the work of O. K. Moore and his responsive environments theory. Our work with the instrument does not involve an attempt to test Moore's theory or to replicate his work. One way to explain our orientation is to contrast it with his.

> Moore starts with the machine phase in which any key the child attempts to press will depress. The letter is typed and the machine voices the name of the symbol. This machine phase demonstrates very clearly Anderson and Moore's notions of "autotelic responsive environments." * In this use of the machine no demand is placed upon the child to attend. What Moore contends is that the child, immersed in this environment, will discover certain critical relationships. His approach is also evident in the fact that the children's fingernails are painted with colors corresponding to the colors of the keyboard keys, in order to develop touch typing. The child is not instructed to hit a yellow-colored key with a yellow finger but this order of relationship seems to develop for many children. The importance for Moore is that the child does this for himself without any external requirements. (Gotkin and McSweeney, 1967)

Our orientation varies from Moore's for three interrelated reasons. First, Moore is concerned with longer amounts of instruction in which children are involved in a variety of environments leading to early reading and writing. Our primary concern involves much more limited amounts of instruction and a parsimonious use of machine or instructional time. Second, as programers we are concerned with developing a reproducible set of instructional events rather than programing for each child. Third, our experiences have led us to question the relevance of Moore's strategy

---

*Anderson, A.R. and Moore, O.K. Autotelic folk-model. Technical Report No. S, New Haven: Office of Naval Research, Group Psychology Branch Contract SAR/Nonr-609 (15), 1959. Also reprinted in the Sociological Quarterly, 1960, 1, 204-216.

for many children coming from disadvantaged backgrounds. It seemed to us that the success of his approach depended upon an already internalized learning set in which the children paid careful attention to their own responses and sought to figure out what was going on.

B. The Instructional Program and its Development: Underlying Models (Chapter III)

This chapter describes, from several vantage points, our general orientation to the *development and testing of the instructional program in beginning reading skills*. Each of these orientations, herein designated as models and summarized below, is important because it provides an explanation for what guided our work over the three years:

1. The researchers are committed to the discipline of programed instruction. The process of that discipline guided the development of the instructional program.
2. There are diverse theoretical positions in the field of beginning reading instruction. The model chosen emphasizes the early production of sounds to letter images. While some attention was paid to visual discrimination, the emphasis was on reading as the oral construction of ordered sounds in relation to ordered graphic images.
3. As programers we are committed to specify in behavioral terms what it is we propose to teach. The outline of the model of the subject matter content is provided.
4. Models are provided describing how the instruction takes place

in terms of the increasing levels of skill and response complexity. Since complex machine technology was used for a portion of the instruction, the nature of the interaction between the child and the machine is considered.

5. Any definition of the instructional events which are designed to accomplish objectives is built upon a specific view of learning.

c. Instructional Strategies (Chapter IV)

In contrast to Moore's responsive environment, our orientation emphasizes an attentional environment. Our approach to programing is in accord with Zeaman's contention that learning is facilitated by the "engineering of the child's attention"(Zeaman and House, 1963). Our approach to the engineering of attention leans heavily on Gibson's perceptual theory which focuses on the critical dimensions of the things to be learned. In an attentional environment we seek from the outset to develop an attentional learning set.

> An attentional learning set refers to behavior in which the child listens to instructions and looks at the stimulus before searching visually for the relevant response. Initially, in the programing we sought to give the child many chances to respond in each lesson. What we found was that in establishing a rapid rate of responding, we also established impulsive key-pressing behavior. Too often, the children sought to find the correct key by what McSweeney has described as "a manual rather than visual search." (Gotkin and McSweeney, op.cit)

1. Motivational Strategies: The body of techniques developed to obtain and maintain an attentional learning set is described in this

chapter under the heading of motivational strategies. Our emphasis on motivational strategies is especially important in view of the fact that the schools have avoided direct reading instruction until the first grade, arguing that children were not ready for reading until they had reached the mental age of six years, six months. It is said that the children have very short attention spans, a point made especially in regard to children from disadvantaged backgrounds. In contrast, we are suggesting that attention span is the dependent variable and motivational strategies the independent variable. With this in mind, we investigated what techniques are available to the instructional programer to help him engineer the child's attention to direct reading instruction.

2. Behavioral Strategies: "Behavioral strategies" are the techniques used to teach the increasingly complex indicating and oral reading responses required in the lesson sequences. The distinction between motivational and behavioral strategies involves the difference between keeping someone involved in a lesson and what that person eventually learns. Television cartoons keep children attentive for long periods of time, yet the amount and type of learning is generally uncontrolled. Unfortunately, many educational activities are evaluated more on their basis to entertain than on their promotion of effective learning.

In this section the reading skills are presented in detail as behavioral objectives and the programing paradigms related to teaching these skills are described. The paradigms underlying the lessons are detailed in terms of stimulus and response chains.

3. Tutorial Strategies (Performance Aides in Teaching): Recently we have been confronted with a new question, "If these reasons for use of machine instruction are so sound, why then did you shift from it to non-machine, tutor-taught instruction?" To this we respond: From the outset we were committed to adapting lesson sequences to other formats. It was always obvious that some of the skills involved could be more readily adapted to presentation by other equipment and by non-mechanical or non-technological modalities.

As the lesson model was more fully developed, it became clear that time to test new aspects of behavioral analyses could be saved by tutoring. Not only did this type of tutoring prove sufficient for identifying critical problems for lesson development but it saved time in preparing lessons for machine presentation. Interestingly enough, the tutorial procedure revealed that all of the persons working on the project had internalized the underlying behavioral strategies built into the machine presented lessons, and were simulating these strategies as they tutored. Finally, these lessons can be easily reproduced and disseminated in a booklet format by means of slides and tapes. This orientation has proved to be especially relevant given the increasing interest in the use of paraprofessionals as members of instructional teams.

D. Validation Studies (Chapter V)

The two validation studies presented in this chapter answer the question: "How well do the instructional sequences accomplish their objectives?" The studies do this by documenting the levels of mastery as well as the amount of instructional time required for the children to achieve these objectives. The data define both the efficiency and effectiveness of the instructional sequences.

Intrinsic to our orientation as programers is a firm commitment to establishing instructional sequences which achieve comparable results with comparable populations in other settings. Examination of innovative educational programs, especially those dealing with young children, indicates that few programs have translated into other settings with anywhere near the spectacular results obtained under the guidance of the innovators. Given this concern with reproducible results, we were pleased to have the opportunity to conduct two validation studies; the first, within our laboratory setting under our supervision, and the second, in another setting under other supervision using the same instructional devices with a similar population.*

E. Transfer study (Chapter VI)

The validation studies discussed in Chapter V indicates that most of the children learned to read analytically seven words in a total of approximately seven instructional hours. These studies demonstrate that the lessons accomplish what they were developed to accomplish and in a reproducible way. Chapter VI raises the further question, "Does the above assessment evaluate all that was learned?"

In teaching a phonically oriented, cumulative sequence of skills, we believed that the children would learn not only the specific content, but would have acquired a set of structural reading skills which would facilitate their acquisition of new reading content. Stated another way, we believed that the skills learned would not prove to be content specific.

---

* The other project is under the general direction of Dr. Miriam Goldberg, Teachers College, Columbia University; and the laboratory under the direction of Mrs. Esther Fink.

The transfer study evaluated this contention by assessing how well the children transferred what they had learned to the acquisition of new phonic material, which covered single sounds and blending skills.

F. Summary, Significance, and Implications (Chapter VII)

This chapter presents a summary of the major data results, a discussion of the overall significance of the study, and a description of some research outcomes and practical implementations of the present work.

In the section devoted to the significance of the study, five interrelated issues are discussed: 1) reading readiness, 2) empirical derivation of the instructional sequences, 3) individualization of instruction, 4) use of complex instructional technology, and 5) the content strategy of teaching a structural sequence of skills.

Among the research outcomes and implementations cited are two reading programs involving a detailed revision of our lesson sequence and an extension of the sequence content to include higher order phonic skills. The first of these programs uses the sequence with dyslexic third- and fourth-graders; the second program adapts the sequence for use with kindergartens. The Performance Aids in Teaching (PAT) booklets are also cited as a practical outcome of our study.

It is suggested, in conclusion, that the children are "learning how to learn," and that our use of motivational strategies, limited lesson content, and a simplified learning environment helped the learner to more successfully grasp well-defined learning structures.

References

Anderson, A. R. and Moore, O. K. Autotelic folk-model. Technical Report No. S, New Haven: Office of Naval Research, Group Psychology Branch, Contract SAR/Nonr-609 (15), 1959. Also reprinted in Sociological Quarterly, 1960, 1, 204-216.

Gibson, E. J. Development of perception: discrimination of depth compared with discrimination of graphic symbols. In J.C. Wright and J. Kagan (Eds.), Basic cognitive processes in children; report of the second conference sponsored by the Committee on Intellective Processes Research of the Social Science Research Council. Lafayette, Indiana: Child Development Publications, 1963.

Gotkin, L. G. and McSweeney, J. Learning from teaching machines. In P. Lange (Ed.), The sixty-sixth yearbook of the National Society for the Study of Education, Part II. Programed instruction. Chicago: U. of Chicago Press, 1967.

Zeaman, D. and House, B. J. The role of attention in retardate discrimination learning. In N. R. Ellis, Handbook of mental deficiency. New York: McGraw Hill, 1963.

Chapter II. The Setting and Apparatus

A. Setting

The project took place in a public elementary school, P. S. 175, in Harlem. An office on the second floor was converted into a laboratory setting. The laboratory housed two ERE machines, three booths, and carrels for three researchers. A cooperative relationship with the school principal and staff enabled us to take kindergarten children, one at a time, from their classrooms each day to the laboratory setting. The two observation booths were situated close enough to the laboratory entrance so that, as the children entered the room, they saw a second entrance leading to the ERE observation booths. After they entered the booth the door was closed and the learning session began. The booth was 4' x 4' x 8'.

During the first 34 lessons, the child was alone in the booth and the ERE machine was the chief instructional agent. During lessons 35 to 62, one of the researchers sat with the child in the closed booth. The researcher, sitting with the child, used specially prepared scripts in book form to present lessons to the children.

B. Apparatus

Lessons were presented by means of two very different devices: (1) the ERE machine and (2) specially-designed scripts in book form which contained words and pictures read and shown to the children by one of the researchers. The ERE machine is described below. The scripts are described in Chapter IV of this report, which includes a general discussion of the use of scripts as performance aids in teaching.

The ERE can be thought of as a combination of simpler media: the electric typewriter, the tape recorder, slide projector, and classroom chalkboard, complete with pointer. The typewriter has a key-locking mechanism which keeps all of the keys locked while other media are being used. For example, all keys are locked while the voice is being played or while the projector is being moved. At any point between picture and voice events in a lesson, the machine may be coded to unlock a single key on the typewriter and all following events will not occur until that key is depressed. The machine will literally wait for the child to depress the unlocked key before proceeding to other events. This unlocked or open key is designated as the correct key in most programing. The locked-key feature has sometimes been interpreted to mean that the child cannot make an error because only the right key can be depressed. However, if the child cannot find this correct key with the information given him, he will inevitably search for it by "trying out" other buttons to see if they will depress. Figures 1-5 illustrate the setting and certain parts of the ERE machine.

At this point it is important to dispel the misconceptions which have evolved around the locked-key mechanism, especially the notion that "the child cannot make an error." Here we would like to emphasize that, because of the locked keyboard, it is virtually impossible for a child to produce a print-out error, but the child can nevertheless make very conspicuous errors in selecting and exerting pressure upon locked keys. These errors, in our opinion, become an important part of the child's behavior.

The tape recorder is represented in the ERE by the "keyvoice," a one-second voice associated with each key, and by longer units of voice which may be varied from 2 seconds to 10 seconds. These units may be chained together to give as much as 20 minutes of dialogue.

The slide projector can be coded to move automatically backward or forward, or automatically turn itself on and off. Various combinations of these codes produce some important instructional effects. For example, a flashing effect is produced by coding the machine to read alternating "on" and "off" codes. Animation effects are produced by a continuous series of "projector forward" codes. Flashing and animation were important motivational and attentional techniques in our lessons.

The familiar chalkboard or blackboard effect is represented in the ERE as a white card mounted directly in front of the child. On this card, information to be displayed to the child can be typed, written or drawn. A red pointer clicks rhythmically from left to right across the face of the card, and can be coded to stop at practically any position on one line, enabling the child to focus on individual letters or digits.

Our lessons make use of a modified keyboard. This device is placed over the standard keys of the typewriter and consists of individually removable filler-plugs and operating keys. Thus the number of keys which a child must deal with can easily be modified by inserting filler-plugs in place of operating keys. Since these modified keys are blank, it is a simple matter to change their content. When the carriage portion of the typewriter (which holds the print-out) is covered by means of an opaque panel, it is possible to vary the position of each key since the child can no longer see what he is typing. All of the lessons reported here involve the occluded carriage and the absence of print-out.

The most complex instructional phase of operation occurs when events employing the functions of some or all of the various media described above are sequenced to produce a coordinated lesson. For example, the slide projector may be turned on to project a letter on the slide screen (event 1). The voice function of the machine may next be pre-recorded to say, "This is the letter named a. Now you say a" (event 2). The key bearing the letter a may then be coded to unlock, accompanied by a 1-second keyvoice which requests the child to "press a" (events 3 and 4). The slide projector may then be coded to move forward to show another slide (event 5), and so on. In coded format the 5 events look like this:

	What Machine Does	What Child Sees and/or Hears
1.	Turns projector on	-a-
2.	Plays ten-second voice	-a- "This is the letter named a, now you say a.". . .
3.	Plays one-second voice and...	
4.	...unlocks a key	-a- "Press a" (Child also hears click of key opening and bell cue).
5.	Projector moves forward to next letter after child presses open key (a key).	-m-

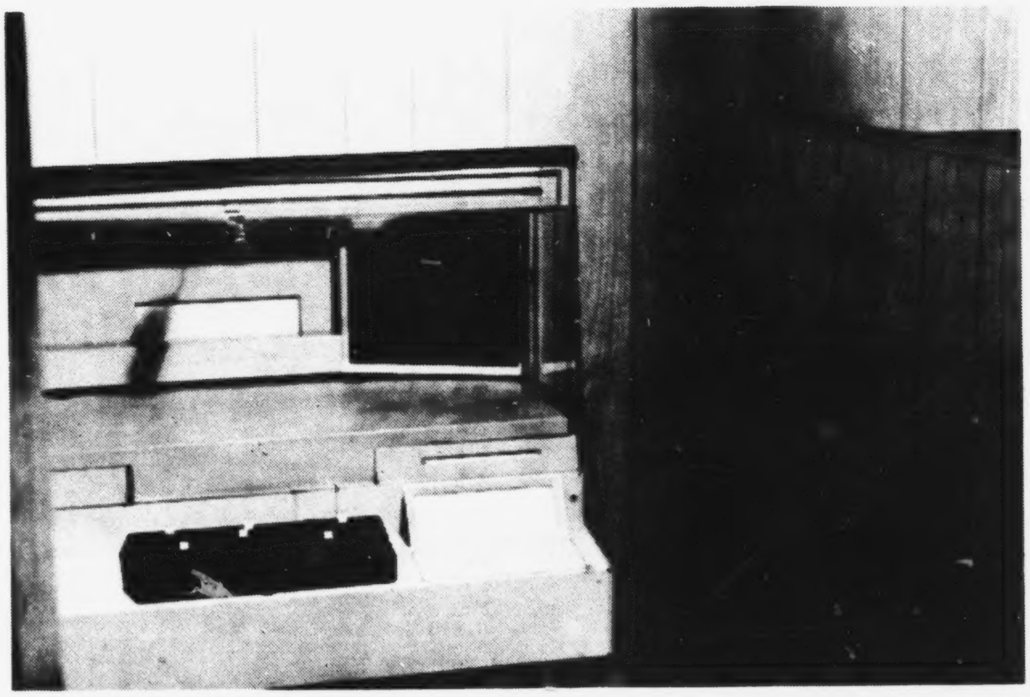


FIGURE 1. ERE Machine and Experimental Setting. One way observation glass is at upper-right. The booth is 4'x4'x8' with one-way observation glass on three sides, a ceiling, and a door.

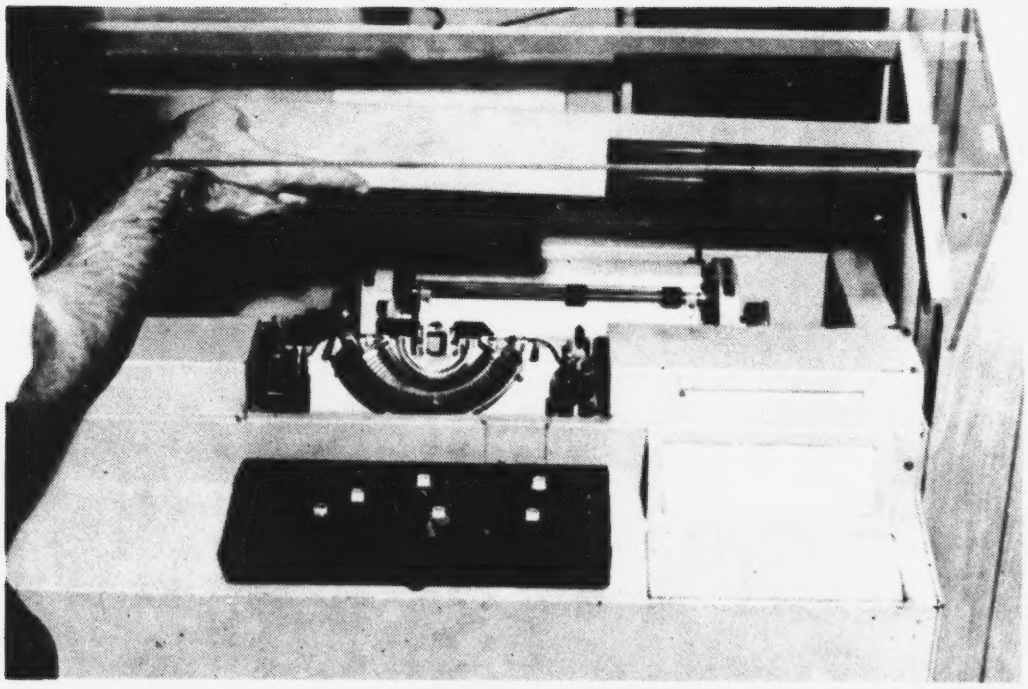


FIGURE 2. Typewriter Carriage. Hand is holding opaque panel which covered carriage during all experimental sessions.

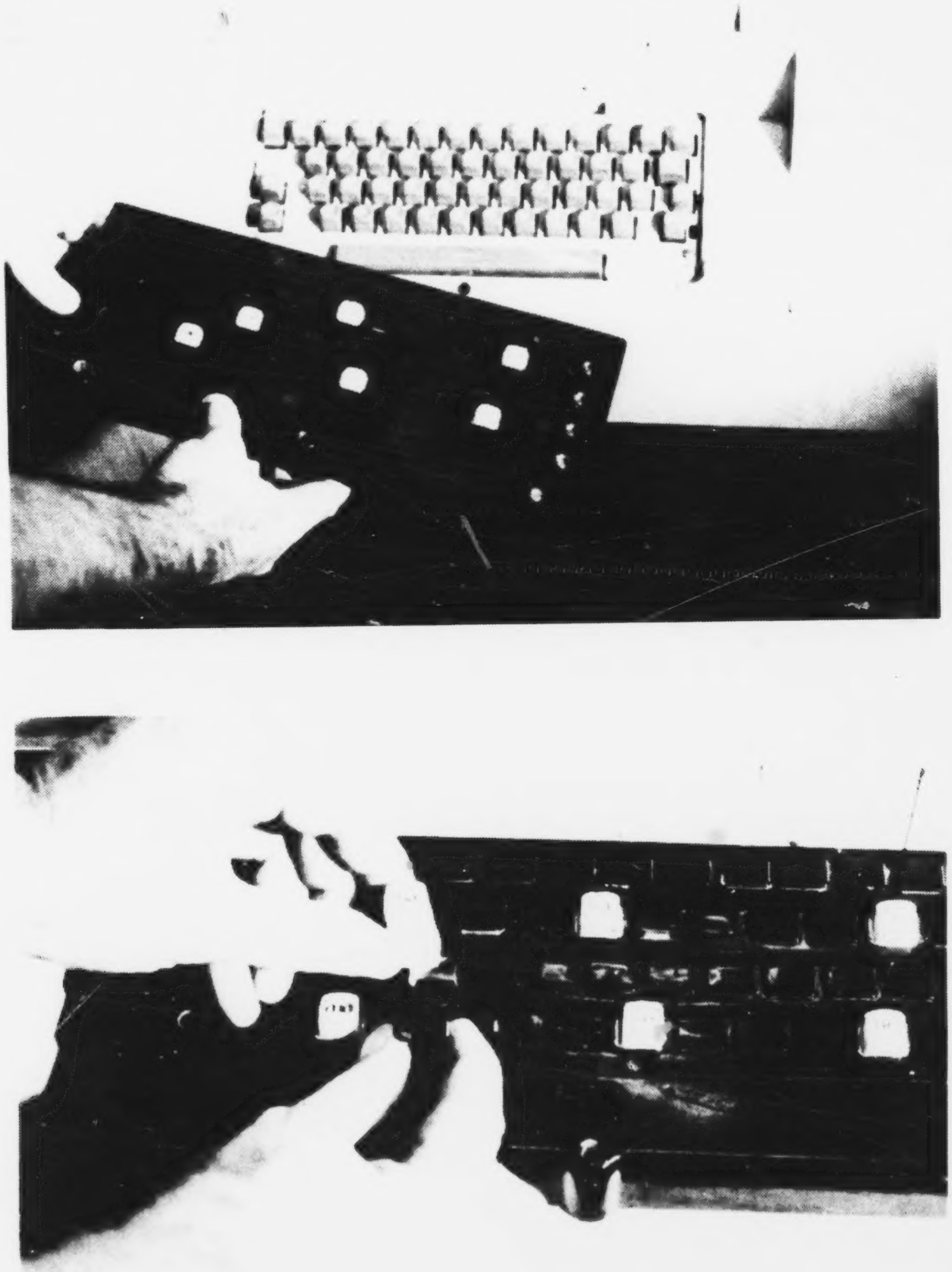


FIGURE 3. AT TOP: modified keyboard being positioned over standard keyboard.

AT BOTTOM: top hand inserting operating key. Note two-letter content on each button.

FIGURE 4. Indicating (pointing) response to letter sound. Keyboard shows five of the six single letters and their positions. Positions of letter-buttons remained the same throughout program.

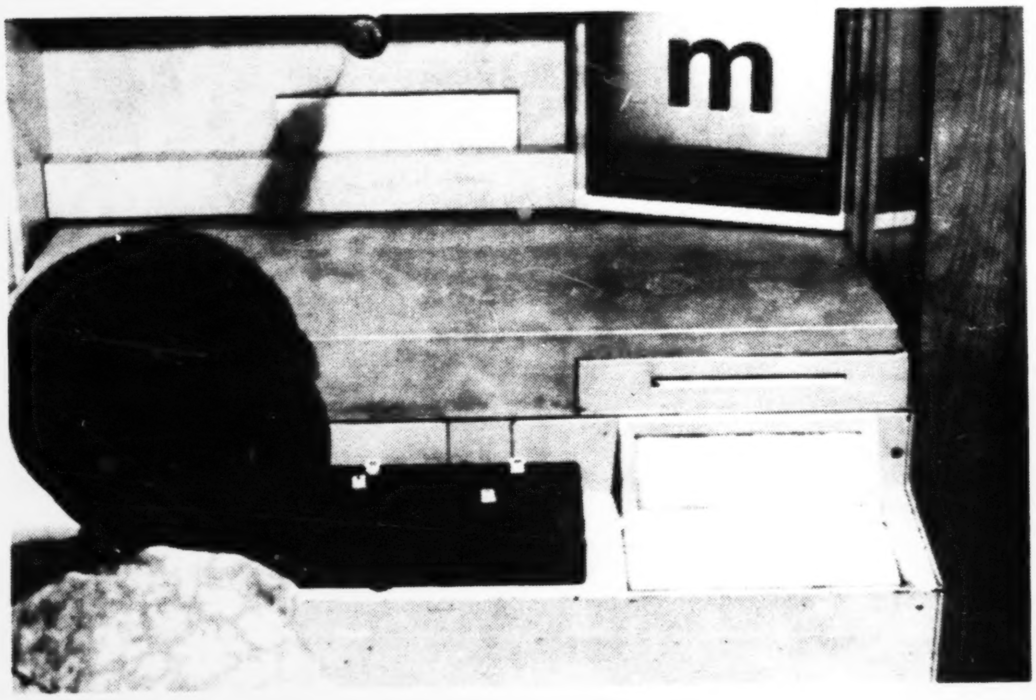


FIGURE 5. Oral response to letter image being projected on screen. (still slides, 2"x2", 36 slides per magazine).

Chapter III. The Instructional Program and Its Development: Underlying Models

An instructional program can be considered from various points of view: How was it developed? What is its subject matter approach? What is its content? (i.e., what and how much information was taught). What models guided the teaching sequence on the one hand, and the learning sequence on the other?

This chapter is divided into five sections which attempt to answer these questions by describing the models that:

1. guided the actual development and testing of the individual lessons as well as the lesson sequences;*
2. define the subject matter approach for the beginning reading skills taught;
3. describe the amount and content of the specific subject matter taught;
4. define the teaching sequence from the viewpoint of how information is presented to the learner (since a considerable portion of the instruction was accomplished by machine, an analysis of the nature of the interaction between the machine and the child is provided);
5. define the learning sequence from the viewpoint of how the learner transfers the teaching sequence into a skilled performance.

A sixth section (F) gives a summary description of the sequence of learning skills.

---

*The developmental history of the program is detailed in Appendix A.

A. Developmental Model

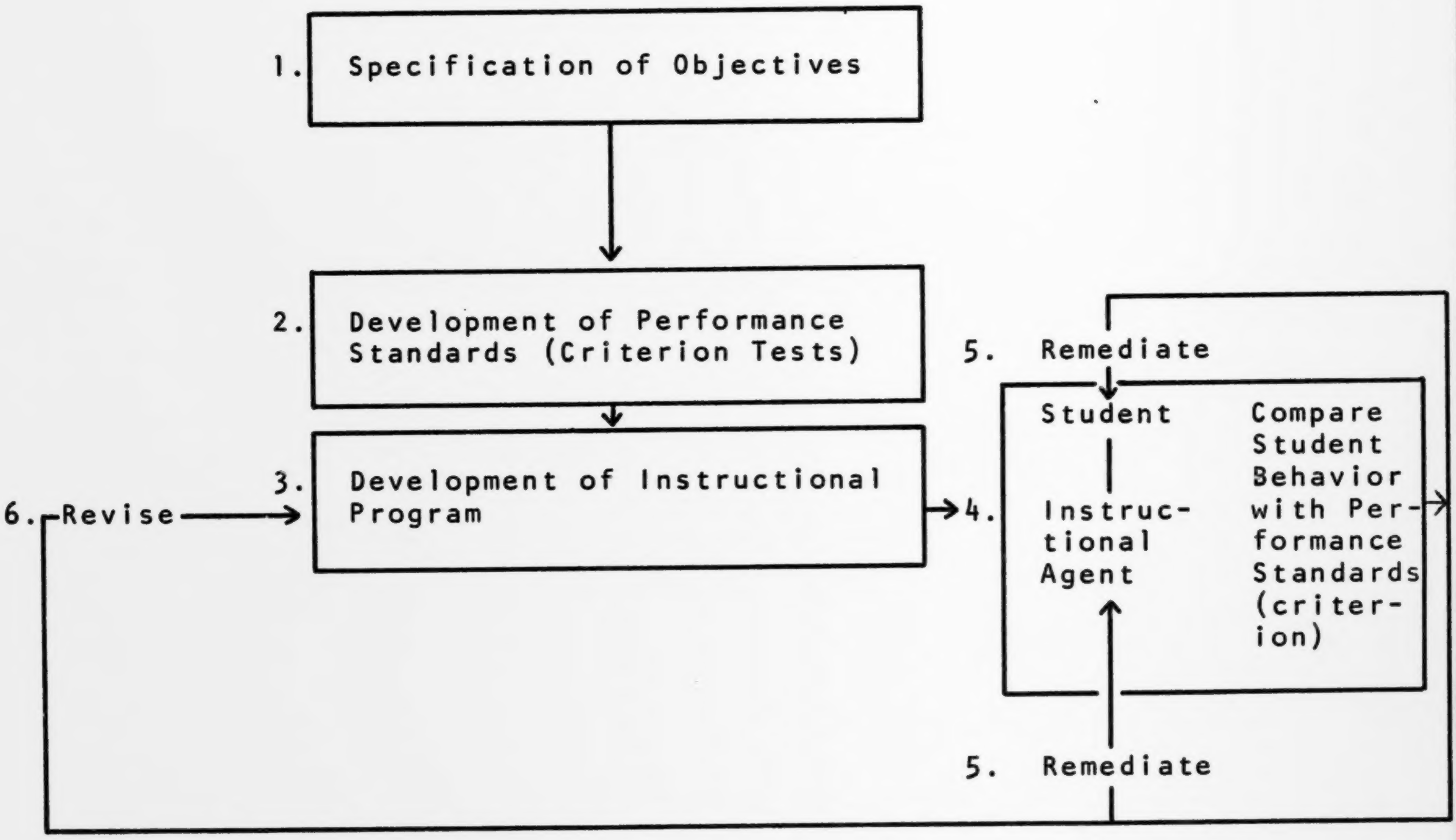
The model which guided the development of the lesson sequence is derived from the field or programed instruction (Lange, 1967). The essential components of this model, more fully defined by Corey (in Lange, 1967), consist of:

1. designing instructional sequences in terms of expected outcomes
2. comparison of actual outcomes with expected outcomes
3. continuous reduction of discrepancies between actual and expected outcomes by successive revisions of instructional program.

In the programing model, the expected outcomes are (1) drawn up in behavioral terms such that the skills being sought are evident in or inferred from observable actions, and (2) are held relatively constant while the program is varied and revised. In experimental terms the outcomes are dependent variables while the program designed to produce the outcomes is the independent variable. Commitment to revision is the heart of the model. Other researchers describe the same process as empirical iterations, tutorial modifications (Silberman, 1964), or empirical derivations (Deterline, 1967). Whatever the terminology, it is clear that the programing model has become an important tool in developmental research. Whether the object of development is an instructional sequence, a larger scale project, a long term program, or a broadly based institution, the description of the programing model as a guide to continuous improvement of process and outcomes is unmistakably present in the language of various project reports and institutional literature (Southwest Regional Laboratories, 1967; and University of Wisconsin, 1967).

Figure 1.

Developmental Model


1. Specification of Objectives
2. Development of Performance Standards (Criterion Tests)
3. Development of Instructional Program
6. Revise
5. Remediate
4. Student
Instructional Agent
Compare Student Behavior with Performance Standards (criterion)
5. Remediate

While the model presented in Figure 1 is an accurate diagrammatic representation of the overall process, its application, over time, is more flexible than implied in the diagram. The model shows criterion standards being held constant while the program is continuously varied as a result of interaction between the instructional agent and student in the learning setting. During the initial phases of development, criterion standards and their resultant tests may be changed quite frequently as interaction between agent and student reveals insights into new and clearer specifications of objectives. As knowledge is gained in the setting, however, revisions in the criterion dimension become less frequent and eventually stabilize. At this point developmental effort concentrates on sequence revisions,and reductions in outcome discrepancy is sought.

B. Subject Matter Approach

The subject matter approach in our program concentrates on reading as a process of first,decoding images in terms of their sounds and second, assigning meanings to the sounds. Reading behavior requires an analysis of images which are first seen followed by a response of saying the sounds represented by the graphic images. In contrast, spelling behavior requires an analysis of sounds which are first heard followed by a response of writing or selecting the images represented by the heard sounds. Hearing sounds and writing or selecting images seems to be an essential dimension of spelling, while seeing images and saying sounds seems to be an essential dimension of reading. One can think of spelling as an encoding process and reading as a decoding process. Encoding requires that sounds be translated by the speller into graphic images, while reading reverses the process, requiring the images to be translated by the reader into sounds.

Because of our subject matter orientation, our instructional program concentrates more upon the oral as opposed to the graphic response to sounds. As a result, the lesson sequence primarily requires children to orally construct letter and word sounds. Some attention is paid to visual discrimination, but only enough to ensure that the children respond to one image as different from all the other images which they must later process as sounds. Some attention is also paid to the selection of images, but only enough to support the later oral response skill of saying the letter sound in response to its graphic image. Thus, the sequence tends to be both specialized and parsimonious because it teaches the child to orally construct ordered sounds in response to an ordered series of graphic images. In contrast to this view, most classroom beginning reading programs involve workbooks and exercises which require the child to write letters and words in response to sounds which are heard. While this is an important objective, we contend that this is primarily a form of spelling behavior. From a subject matter point of view, we see spelling as ancillary to reading. Its existence in most classroom reading programs, however, tends to complicate the more rigorous definition of reading in our own program. We are not, at most times, seriously concerned with shaping encoding behavior. We are primarily occupied with the decoding dimension which is highlighted by the child's oral response to graphic images.

It is important to distinguish between a subject matter position which is primarily phonetic or phonics oriented and one which is concerned (as we are) with a more general view of shaping the child's oral response to letter and word images. A phonics position has been characterized as a concern for the regular sound relationships between letters and words. A great deal of literature has evolved debating the efficacy of phonics since many of our English words exhibit irregular sound relationships. Our own position is more general. Regardless of whether or not the sounds and images which the child must negotiate are regular or irregular, the underlying process of assigning a sound (regular or irregular) to an image (regular or irregular) remains the same. We see phonics as a special case of decoding images in terms of sounds. The response forms and skill sequence which we defined to teach the sounds of regularly phonetic words are equally applicable to words which do not conform to regular sound patterns. They are applicable because in both cases they contribute to a teaching problem common to both regular and irregular words, that of enabling a child to produce particular oral responses to particular graphic images.

In the branch of mathematics called statistical decision theory, mathematicians speak of mini-max solutions. Such solutions seek the maximum results for the minimum input. In any project, research or otherwise, the investigators are faced with restrictions. These restrictions are formally referred to as the parameters of the problem. A major parameter or restriction that governed our work was the amount of instructional time required. Thus, we asked ourselves, "How much instruction could be accomplished in approximately 10 hours and what instruction would yield the greatest payoff?"

In the initial stages of the project the critical issue became the definition of reading and the reading skills to be taught. As one examines the various types of approaches to reading it becomes obvious that some approaches focus on readiness activities that are not reading behavior. For example, while it is possible to argue from a developmental point of view that the handling of three dimensional wooden letters readies a child for later work with both reading and writing, this does not mean that the actual behavior in handling those letters and in dealing with visual discrimination problems in letters is reading behavior. Some approaches focus on writing. For example, a major work is headed "The Writing Road to Reading." Other approaches emphasize personalizing the content.

Our approach focuses on reading behavior. That is, we chose to study reading in its distinctive form. By doing this we were able to get maximum time dealing with reading behavior and the problems involved therein. Furthermore, by undertaking such a task we challenge many of the assumptions about how necessary certain experiences are as preparation for reading. In challenging some notions of readiness, we do not challenge the desirability of having such experiences for the child. Rather, we merely ask whether those experiences are necessary before one moves into direct reading instruction with five year olds.

C. Content Model

The content of the first 62 lessons consists of the following images and sounds:

1. Single letter images

   m, o, p, s, a, t

2. Bigram images

   mo, so, po, ma, sa, pa

3. Trigram (whole word) images

   mom, mop, pop, pot, sam, pat, sat

The sounds associated with the images are as follows:

Image	Sound
m	"mmm"
o	"o" (as in pot)
p	"puh"
s	"sss"
a	"a" (as in sat)
t	"t" (as in pat)
mo	"mo" (as in mom)
po	"po" (as in pot)
so	"so" (as in sock)
ma	"ma" (as in map)
sa	"sa" (as in sat)
pa	"pa" (as in pat)

While this content appears limited, our concern in this project was not with the amount of content, but rather with the variety and complexity of skills which a child could apply to this content. Our primary objective was to define and then to teach all of the skills essential for the analysis and synthesis of trigrams within a framework of limited content. If words are selected that neither look nor sound alike, it is not difficult to teach a child to "read" seven three-letter words. Most children can be taught to memorize the word sound associated with each word image. The child is presented with the word image mom; he says the word sound "mom," etc. These are simple look-say associations of sound ("mom") with image (mom). A child who can produce word sounds in the presence of corresponding word images can be described as a "look-say" reader.

Our concern was with another kind of reader whom we prefer to characterize as analytical. The analytical reader brings to word images a greater variety of sound-symbol and perceptual skills. For example, the analytical reader can not only use the look-say skill in producing word sounds in response to word images, but beyond this he can perceive a three letter word as made up of component visual and sound parts. The image mom is perceived as mo and m, or m, om, or m, o, m (depending upon which particular subframework he has been taught). He not only visually perceives the subunits of a word but can produce their corresponding sounds in left-to-right order and can culminate his analysis by blending or synthesizing the subunits into a related whole-word sound. The children in our program were taught to analyze the image mom into two parts: mo, m. They were then taught to produce the sound of the first unit ("mo") and then the sound of the second unit ("m") and finally, to blend the two parts together as the whole-word sound ("mom").

A look-say reader is limited to one skill level, i.e., producing word sounds in response to word images. No word analysis or synthesis is required of such a reader. The analytical reader can (1) break a word image into visual and sound parts, (2) scan the parts in left to right order, (3) produce the sounds associated with each part and (4) recombine the separate sound-parts into a whole-word sound. The power of such complex behavior is evident when such a reader encounters unfamiliar whole-word images made up of familiar parts. The argument that analytical readers evolve from look-say training without explicit attention being given to the separate analytical and synthesizing skill has not been substantiated in research bearing on this point (Silberman, 1964). With the exception of bright children, the average population, in our experience, cannot efficiently induce sound relationships from look-say training. These skills require specific definition and systematic presentation in lesson sequences.

D. The Teaching Model

How the teaching takes place will be discussed from two points of view: (1) the structure and progression of events as they unfold to the child and (2) the nature of the interaction between child and machine, i.e., how the exchanges between child and machine are initiated, maintained and ended.

1. Sequence of Events: The sequence is organized in such a way that the child is exposed to increasing levels of skill and response complexity. During the early part of the sequence, the child is using skills, such as the matching of letter shapes, which he possessed before coming to the sessions. The matching of letter shapes is used as a basis for teaching the child to respond to letters in terms of their sounds in left-to-right order. Letter-order skill, in turn, forms the basis for the blending of letters. In general, the skills are arranged in levels of complexity, with mastery at lower levels being prerequisit to entry at higher levels.

Within each skill level, moreover, there are finer subdivisions of response complexity. For example, at the single-letter level, the child listens to the machine say a sound and the child immediately reproduces the sound. This is a low-level echoing response. Later on the child is presented with the letter image and is asked to say the letter sound. This is a higher level, constructed response. The child must recall the sound from memory and reproduce it without the aid of an echoing model.

Between the extremes of echoing and fully constructing the response on his own, there are intermediate levels of response complexity:

Level of Response Complexity		
low (echo)	-m- this is mm, say mm	model of the answer provided immediately before child responds
intermediate (oral selection)	-m- is this mm or ss?	a choice of answers is immediately provided
high (oral construction)	-m- what sound is this letter?	no choice, no model; child must recall and produce

The formalization of increments in response complexity as an organizational scheme for the entire program was empirically derived. During the early phases of lesson development we frequently observed children succesfully echoing sounds in the presence of letter images. This level of response complexity was followed by questions requiring the child to orally construct (recall and reproduce) a particular letter sound for a given letter image. A good deal of failure and hesitancy was observed from this sequencing of echoes followed by constructions. We reasoned that interposing a response of intermediate complexity between echoes and constructions would result in more successful oral constructions. The oral-selection response served such an intermediary function. Lessons were revised to begin with echoes followed by selections and terminating in constructions. This organization can be generalized as including response forms which are initiating, supportive, and terminal. The echo initiates the oral response, the selection supports the response in reaching the terminal or criterion level of full construction.

Another unique aspect to the organization of the sequence is the particular amount of information which must be mastered at each skill level before proceeding to the next level. At the level of single-letter sounds some programs require that all the single sounds be mastered before going on to blending. In our program, only six single letters are required before a child begins blending three-letter words. With six single letters we derive seven trigrams. One effect of this organization is that the child spends less time at any one skill level. To master all single-letter sounds first before proceeding to higher skill levels would result in a good deal of knowledge about one skill level instead of some knowledge about a variety of skill levels.

The sequence then unfolds before the child on two orders of complexity: (1) a series of lessons corresponding to one skill level followed by another series at a higher skill level (for example, the child progresses from the bigram to trigram level) and (2) within each skill level individual lessons of increasing response complexity (i.e., echo response, oral selection, oral construction).

2. Interaction: Anyone watching the interaction of child and machine through the one-way vision glass would see and hear the following dialogue:

Machine: Hello.

Child: Hi.

Machine: Are you ready to play today?

Child: Yes.

Machine: This time you have three buttons.
Do you see them?

Child: Yes.

Machine: Look down at your buttons. Each one has a letter on it. Watch...I'll show you what I mean. (Machine shows a photo slide of button with a finger pointing to the button). This is a picture of a button with a letter. Now you say, "it's a letter."

Child: It's a letter.

Machine: Look down at your letter button. One of your buttons has a letter which looks like my letter. Do you see the button?

Child: Yes.

Machine: Just like the finger in my picture?

Child: Sure.

Machine: When you hear the bell, press the button. (Machine rings bell and opens key).

Child: (Presses button)

Machine: Let's do that again.

Child: Okay.

The startling aspect of this dialogue is that the machine appears to be reacting to the child's response in the same manner as one person would to another person in a face-to-face conversation. The machine was prepared to play this conversational role by programing pauses or brief periods of silence at those points in the lesson which called for a child's response. The actual machine program, played without the presence of the child, would sound like the following (the dots should be read as several seconds of silence): "Hi.....Are you ready to play?.....This time you have three buttons, do you see them?....." The interaction is conversational, like a series of verbal exchanges between two persons. The machine initiates each exchange and then directs the child's responses at every point. Like a Socratic dialogue in which the master scholar leads his student through a series of questions, commands, and declarations, the machine is programed to lead the student.

This conversational interaction is aptly described as attention and response engineering in which a major teaching effort is devoted to initiating, focusing and maintaining the child's looking, listening and oral response behavior. This description stands in sharp contrast to the idea of a free exploratory environment where the child is often expected to produce a larger number of trial responses.

But, what happens during the brief periods of silence when the machine pauses for the child's expected response and the child in fact does not respond? The machine's response is contingent upon the passage of time, not upon the child's behavior. Only so many seconds of machine silence are allotted for the child's expected response. If it does not come, as expected, the machine continues and exposes the child to the next event. An exception to this pattern occurs with the button-pressing response where the machine cannot proceed until the correct button has been pressed. In this one case the machine's behavior is contingent upon one aspect of the child's behavior, his depressing the one key which is open.

The machine's dialogue is built around units of commands, questions, and declarative sentences. These units are then linked together as supportive chains. The structure of each unit has three parts: 1) a direction, question, or declarative, 2) a pause for the child's oral response, and 3) feedback:

unitary model of dialogue

-m-

Say the sound of this letter . . . . it's mm.

(direction) (pause) (feedback)

If the child does not respond during the pause, the machine continues playing the feedback and the child hears what he should have said (it's mm). For a child who does not respond in this situation, the feedback would be quite useless unless he has an opportunity to put it to use immediately after receiving it. For this reason, the units are systematically linked together as supportive chains in the following manner:

chaining model

-m-

1st Unit: Say the sound . . . . it's mm
-m-
2nd Unit: What sound is it? . . . . it's mm

If the child responds incorrectly or fails to respond at all in the first unit, he receives the feedback in the first unit and has an opportunity to use that feedback in answering correctly during the second unit. For the child who responds correctly the first time, a second unit is simply repetitious. The value of this chaining procedure lies in its corrective effect upon those children who take too long to respond or who respond incorrectly during the first unit.

The interaction between child and machine may be summarized as follows:

1. There is a conversational, game-like tone.
2. The machine appears to react to the child's response, but in fact is responding to the passage of time.
3. The child is actively engaged at every point in the lesson.
4. The machine initiates, directs, maintains, and ends all exchanges.
5. Like a model Socratic teacher, the machine leads the student through the lesson, providing (a) many opportunities to respond, (b) immediate feedback for each response and (c) an opportunity to answer more quickly or correctly a second time to the same question.

E. Learning Models

Some learning models seem more appropriate in guiding instruction for one kind of skill and one level of student than another. The teaching of letter sounds requiring children to form simple, direct associations between symbols and sounds is better guided by models developed from the psychology of imitation or theories of stimulus-response behavior. Inappropriate to the teaching of letter sounds would be gestalt models which place greater emphasis upon more complex forms of behavior such as problem solving. Yet, within the sphere of beginning reading there are occasions where conceptual behavior is necessary. One such occasion is in the learning and implementation of complex word attack skills. The child should eventually be able to scan several images and revise his perceptions in a variety of ways.

The latter position assumes that, in the teaching of practical reading skills, several learning models are relevant. That is, each of the models should be relevant to the kind of skill to be learned and the level of the students who are being taught. The earlier behaviors in the reading sequence are better shaped according to principles of stimulus-response and imitation models of learning, while the later behaviors involving rules and abstractions are better shaped by more complex models of learning (Ball, 1968).

In Section D of this chapter we stated that the teaching sequence unfolds to the child on different levels of complexity. To help the child transform this sequence into skilled performance, he is paced through increasingly complex teaching events requiring a corresponding gradation in performance complexity. The child begins his performance at a simple imitation level, progresses through discrimination levels, and terminates at the conceptual level. Each level of learning has its distinctive instructional features which set it apart from other levels.

At the imitation level the simplest kind of performance is the echoing of letter sounds. In the echo response, a model of what to say is provided for the child immediately before he is asked to respond:

-m-

This is mm, you say mm (child says mm)

Say it again, like this, mm (child says mm)

After a number of echoes the child is then asked to discriminate among the sounds which he has echoed.

-m-

Say the sound of this letter...(child says a sound)...

...It's mm. (feedback)

Here, unlike the echo, no model of what to say is provided before the child responds. On the other hand, a model of what the child should have said is provided after the child's response.

At the echoic level the child is imitating a model. This level of instruction assumes that the child has had no prior experience in performing the desired behavior. Therefore, the imitation level provides a significant opportunity for the child to assimilate the sounds and images into his repertoire. In contrast, the discrimination level assumes that the child has had some experience in producing sounds to letter-images. Unlike the echoing process, the questions and commands characteristic of the discrimination response level probe the child for evidence that he is in the process of forming reliable associations of an image with its correct sound. Providing immediate feedback of what he should have said helps the child to (1) revise a wrong association, and (2) strengthen a weak, halting association. (The desired associations are quick, automatic, and devoid of pauses.)

After a number of discrimination responses have been successfully completed the child will have internalized the sound-symbol system. At that point he will have progressed to the self-correcting or conceptual level. This internalized system begins to serve as a governor, map, or guide for the child in adjusting or correcting his own behavior. The child would then require little outside assistance in the form of immediate external feedback. As long as he is still functioning within the discrimination level, however, the child is still in the process of forming a reliable system of associations and will continue to be dependent for corrective information on some external source.

The child's progression through the imitation, discrimination, and conceptualization response levels is dramatically evident in the learning of complex behavior such as blending. Children who have internalized sound-symbol and blending rules can easily be observed correcting their own behavior.

F. Summary Description of Skill Sequence

The final version of the program that evolved as a result of repeated revisions is described below. This description presents only the main sequence of skill objectives as they occured in the lessons. A more detailed exposition of the program is presented in Appendix D which includes a more precise description of objectives, the sequencing of content, and the behavioral structures, in paradigm form, of the various skills.

Presented below are the initial and criterion objectives for each main skill in the program. The intermediary supporting skills are detailed in Appendix D.

Objectives

1. Objective: Machine working skills, button ressing, button pointing

   Specification: The child looks at, points to and presses typewriter key in response to the machine's words, "Look at, point to or press the button."

   Example:

   "Look down at your button. Point to the button with your finger. Now when you hear the bell, press the button."

2. Objective: Echoing, oral response to letter image

   Specification: Given an auditory model of a letter sound, the child orally repeats the sound in the presence of the visual image.

Example:

" The sound this letter makes is o, you say o." (Child says "o.")

3. Objective: Sound to symbol correspondence, indicating the letter image in response to its sound

   Specification: Given the letter sound, the child points to or presses one of three letter images.

   Example:

   "Point to the letter that makes the sound m."

4. Objective: Symbol to sound correspondence, oral constructed response to letter image

   Specification: Given the letter image, the child says its letter sound.

   Example:

   -p-

   "Look at this letter. Say the sound of this letter."

5. Objective: Unitary oral response, symbol to sound correspondence, orally producing the blended sound of a two-letter (bigram) image

   Specification: Given a two-letter image and an auditory request to say the sound of both letters together, the child orally produces its blended sound.

   Example:

   -ma-

   "What sound do these two letters make?"

6. Objective: Letter order, ordered oral construction

   Specification: Given the two letters po and the instruction, "Say the sound of the first letter and then the last letter," the child first says the sound of p and then the sound of o.

7. Objective: Echoic chain, letter blending

   Specification: Given an auditory model of an ordered series of letter sounds, the child orally repeats the series in the same order.

   Example:

   "Say m, a, ma." (Child says, "m, a, ma.")

   "Say pa, t, pat." (Child says, "pa, t, pat.")

8. Objective: Perceptual set

   Specification: Given a three-letter word such as pat and the instruction, "Say the sound of the first two letters and then the sound of the last letter," the child first says "pa" and then "t."

   Example:

   pa/t

9. Objective: Bigram and trigram blending

   Specification: a. Bigram blending

   Given two letters and auditory instructions, the child says the sound of the first letter, then the last letter, and then both sounds together.

   Example:

   -ma- "m," "a," "ma"

   b. Trigram blending

   Given three letters and auditory instructions, the child says the sound of the first two letters, then the sound of the last letter, and then the whole word.

   Example:

   -pat- "pa," "t," "pat."

References

Ball, S. Learning and teaching. (Mimeographed report, Teachers College, Columbia University). New York: 1968.

Corey, S.M., The nature of instruction. In Lange (Ed.) _The sixty-sixth yearbook of the National Society for the Study of Education_. Chicago, Illinois: U. of Chicago, 1967.

Deterline, W. A., An empirically designed and developed multimedia system. J. of the Nat'l Soc. for Programed Instr., Vol. 6, 1967.

Lange, P. C. (Ed.) _op_. cit.

Silberman, H. F., Exploratory research on a beginning reading program. Santa Monica, California: Systems Development Corp., 1964.

Southwest Regional Laboratory, The role of regional education laboratories. Inglewood, Calif.: SWRL, 1967.

University of Wisconsin. Project models. Madison, Wisconsin: U. of Wisc., 1967.

Chapter IV. Instructional Strategies

The three sections of this chapter describe three different but related instructional strategies which were developed in the project. These strategies are related to different aspects of the general problem of accomplishing instructional objectives successfully. They are:

1. If you wish to make use of complex machine technology for instruction,what kinds of motivational strategies are available within lessons to maintain the child's involvement in and responsiveness to what is to be learned?

2. If you are able to maintain the child's involvement in and responsiveness to what is to be learned, are there systematic ways of presenting and analyzing the reading skills behaviors to ensure that they are mastered?

3. If you have developed reading sequences that make use of complex instructional technology, how might you organize the presentation of the lessons into less complex and less expensive instructional format?

A. Motivational Contexts

This section describes the body of techniques used in the ERE beginning reading program to maintain the childrens' attention. Our emphasis on motivational strategies is particularly important in view of the fact that the schools have avoided direct reading instruction until the first grade, arguing that children are not ready for reading until they had reached the mental age of six years, six months.* One aspect of this argument is that

---

*See Mabel Morphett and C. Washburne, "When should children begin to read?" Elementary School Journal, 1931, 21, 496-503
For an interesting analysis of different approaches to beginning reading, see Jeanne Chall, Learning to read; the great debate. New York: McGraw-Hill, 1967

the children have very short attention spans, a point made especially in regard to children from disadvantaged backgrounds. We maintain, however, that attention span is a dependent variable and motivational strategies the independent variable. Thus, we have asked, what techniques are available to the instructional programer to help him engineer the child's attention to direct reading instruction?

Letters, which are the essential stimuli we have to deal with in beginning reading instruction, are _not_ particularly exciting images for young children. The information and excitement which can be drawn from letter symbols as a result of reading are beyond the competence and comprehension of _prereaders_. While the reinforcing effects of excitement, interest, information or just the sheer exercise of ability accrue to _readers_ as a result of applying learned decoding and interpretive skills to letter symbols, for the _prereader_ there is little in the symbols themselves which can be reinforcing until the letters are decoded and meanings assigned. These dry symbols which convey little of their ultimate value to the young _prereader_ must be mastered. In programing for the reader the problem is to make each use of reading skills a reinforcing event. In programing for the _prereader_ the problem is to make the vocal and attentional responses to letter images (i.e., looking, listening, and saying) reinforcing events. These attentional and production responses form the underlying basis for shaping the decoding and word-meaning skills which enable the child to experience the later reinforcing effects of reading itself. Before a letter can be decoded it must be looked at (attentional response). Before a child can _produce_ a relevant sound response to a letter image he must listen (attend) to the voice which is requesting this behavior. The behavioral requirement is to look at a letter or letters, listen to relevant information about the letters displayed and then to say something in conjunction with the images, usually the sound of the letter involved. All of these attentional behaviors precede the actual decoding and interpretive behavior which is normally called reading.

The problem we faced early in our work was maintaining the child's attention to the audiovisual stimuli. These stimuli were essential in producing the responses which we, in turn, used to interpret the progress of both the child and our own techniques. The many social distractions in classroom teaching which compromise attention to lessons were eliminated by a special booth. But attentional problems persisted within this special environment. Each child works alone in an enclosed booth (4' x 4' x 8') unaware that he is being observed through one-way vision mirrors. The booth and the machine offer a variety of visual and tactile sensations. There are mirrors to be looked into and an assortment of machine parts to touch. The controlling effects of a live teacher and group conformity are absent. The setting facilitates a sense of autonomy, and the child is faced with a choice of behaviors, ranging from fully attentive participation in the lesson to total playfulness, representing the extremes of assorted options. The lesson being played by the machine represents only one, from among many, set of stimuli to which the child may devote his energy. The lesson must compete for the child's attention with such activities as looking in the mirrors, playing with the microphone, opening and closing the booth's door, and so forth.

This section describes a group of techniques which have helped us maintain the child's attention to the audiovisual stimuli. Figure 1

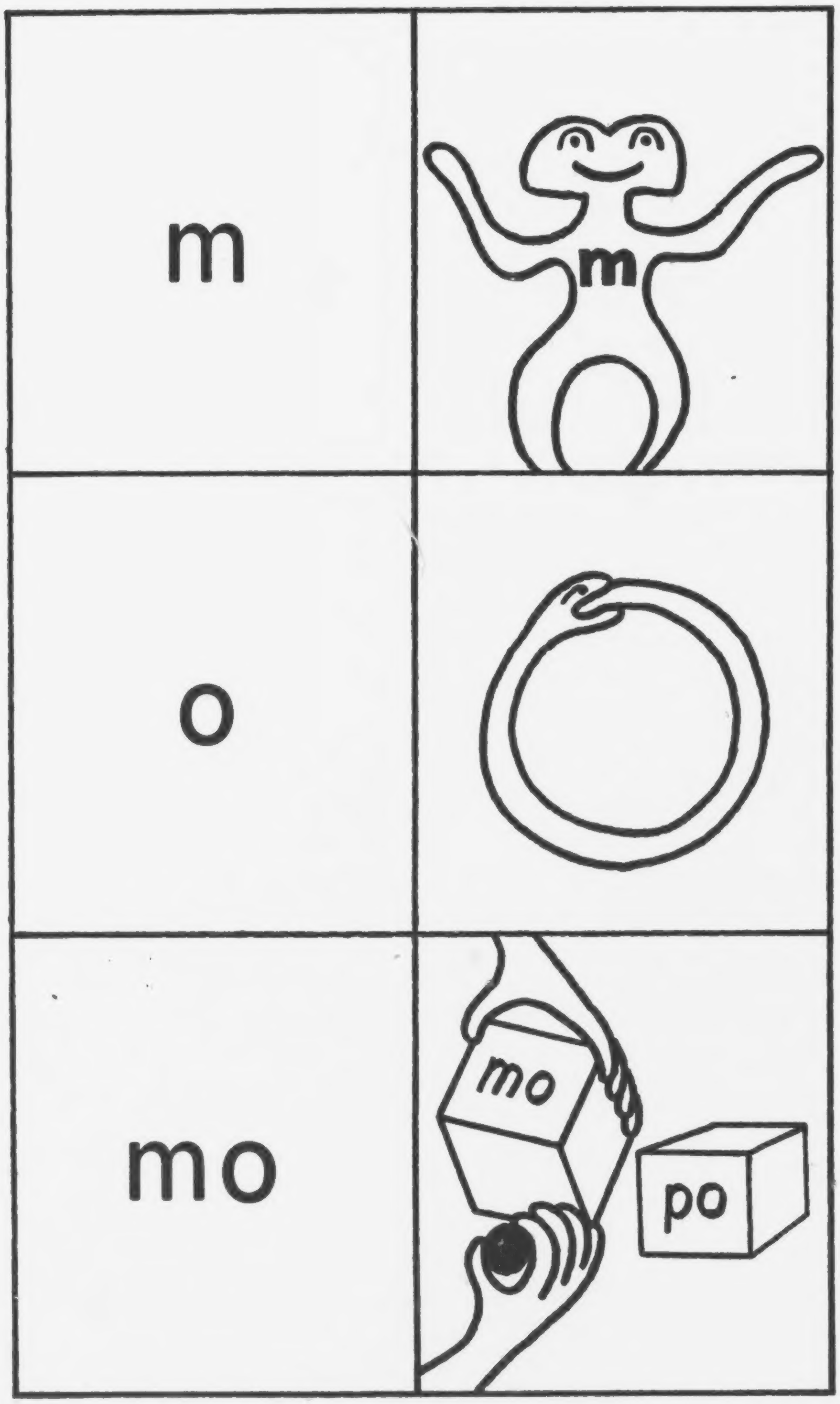


FIGURE 1. Minimal context (left) compared with motivational context (right).

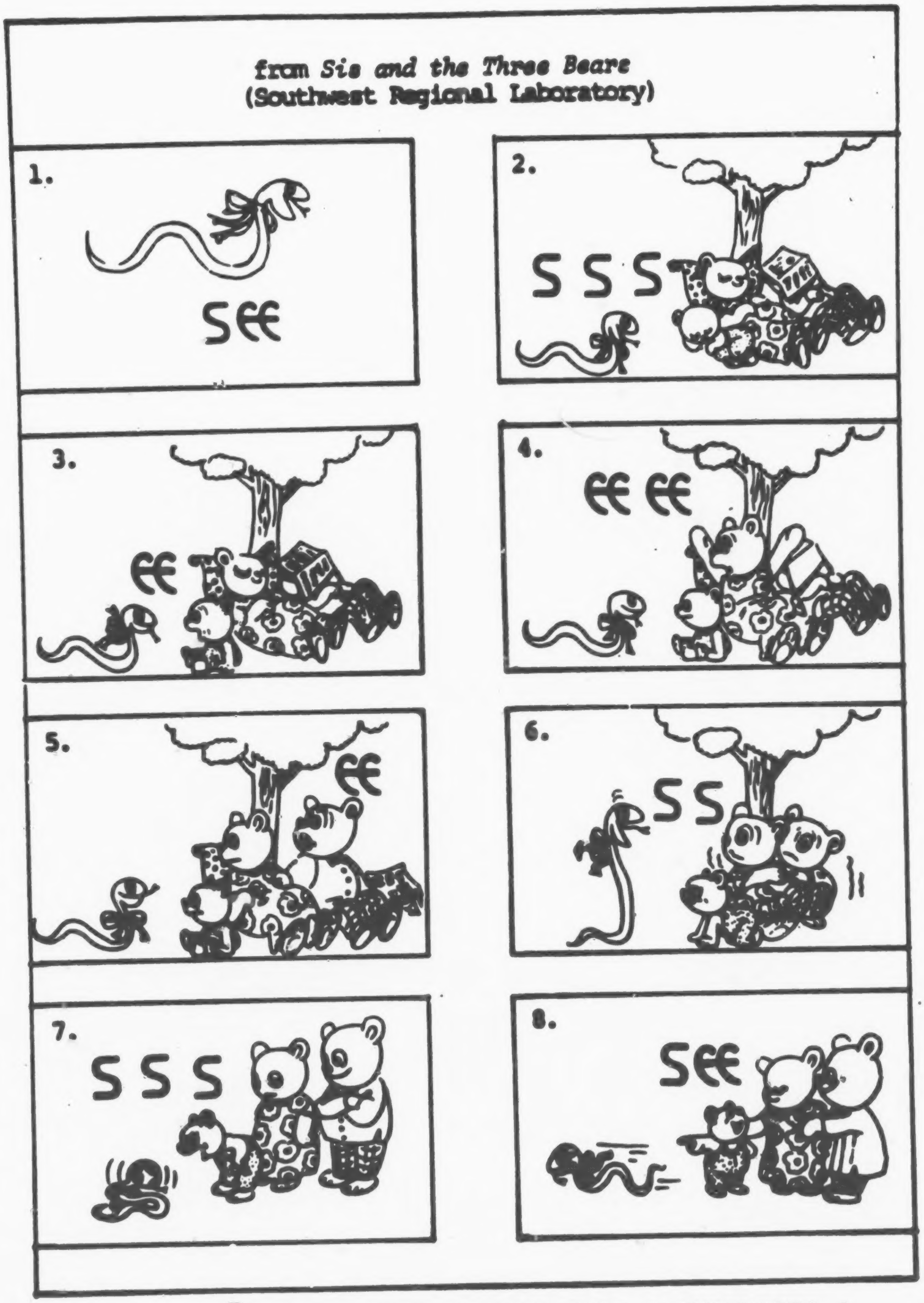
defines a minimal context in which a plain letter is displayed, in contrast with a motivational context, in which the letter occurs as part of a story or game sequence. A minimal context is simply a display of a plain letter, and a request for some relevant behavior, such as "Say its sound." A more motivational treatment places the letter on the body of a fantasy animal, or shows a snake formed into a letter shape or uses letters to define a particular object, like the box in the game illustrated in Figure 9. The context can be expanded to include sequences of such images which form stories and games, appealing to the interests of young children.

Each of our lessons has some such context--a story, game, or series of interesting illustrations--which carries the content behavior. Moreover, each lesson has a different context. Variety and novelty are very effective in reinforcing attentional behavior. Under the assumption that certain events will be attended to because they occur infrequently, the probability of such infrequent events producing an attentional response increases over time. By varying the lesson contexts over a wide range of situations one can, as a result, approach an automatic control of attentional behavior.

In applying the reinforcing properties of variety and novelty to actual lessons, programers must be certain that every lesson has something different in its context in order to maintain attention. It is not enough to know that variety and novelty are reinforcing and ought to be used more often in practical teaching. What is needed are explicitly formulated models which become tools for programers to produce large numbers of interesting lessons. However, explicit models which programers can use to systematically exploit the known reinforcing effects of variety and novelty on a large scale are not presently available to us. The following discussion describes the framework which we used in deriving the contexts for lessons 1-34 presented by the ERE machine.

The framework for deriving the motivational aspect of lessons distinguishes between the content of a message and the context which carries it. This distinction permits us to define and compare varying degrees of plausibility and simultaneity in the associations between content and context. At one end of the continuum, context and content are both plausible and simultaneous within a culturally normal reference system. Using the letter S in conjunction with the hissing sound of a snake (sss) or using the word snake as a mnemonic for the letter s are examples of a plausible relation between content (s) and context (snake). Coleman (Figure 2) has offered some cartoon-like stories teaching the blending of S and ee in a setting of plausibility. The hissing snake (sss) approaching the cartoon character and the sound of dismay (ee) from the character at the sight of the snake are plausible relations between content (blending S and ee) and context (fear of snake). The lesson context is culturally plausible according to our own experiences .

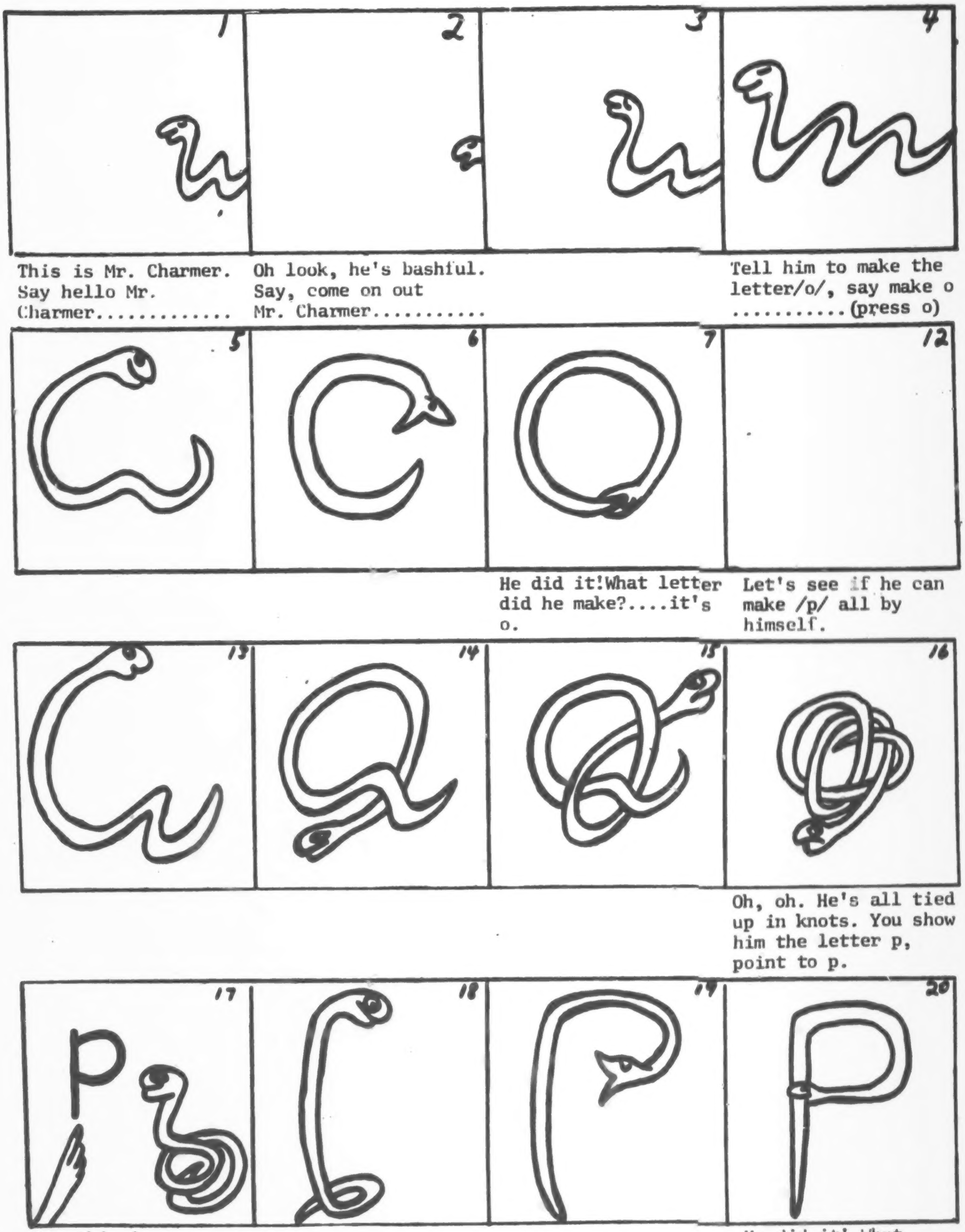
Watching a snake form itself into letter shapes, while less plausible, is certainly an example of simultaneity between context (performing snake) and content (letter shapes). In the Mr. Charmer segment (Figure 3), the letter transformed into a snake becomes an interesting image to look at. It is difficult to find a pure case in which a letter image alone, as an object by itself, can be motivationally treated. A snake under any condition is usually an interesting image to look at. Letters under most normal circumstances are hardly among the most exciting stimuli for young children.



from *Sis and the Three Bears*
(Southwest Regional Laboratory)

EXCERPTS FROM A BOOK THAT ILLUSTRATES A TECHNIQUE THAT CAN BE USED FOR TEACHING PHONICS WHEN THE COMPONENT SOUNDS OF THE WORDS CAN PLAY A MEANINGFUL ROLE IN THE STORY.

FIGURE 2. Text and illustration by Coleman (1967). An example of culturally normal associations between content (s and ee) and context (fear of snakes).



This is Mr. Charmer. Say hello Mr. Charmer............

Oh look, he's bashful. Say, come on out Mr. Charmer..........

Tell him to make the letter/o/, say make o ....(press o)

He did it!What letter did he make?....it's o.

Let's see if he can make /p/ all by himself.

Oh, oh. He's all tied up in knots. You show him the letter p, point to p.

Say this is p....... Say make p.......... (press p)

He did it! What letter did he make? ....it's p.

FIGURE 3. Mr. Charmer. An example of culturally normal associations between content (saying letter sounds) and context (performing snake). (Mr. Charmer is not available for demonstrations).

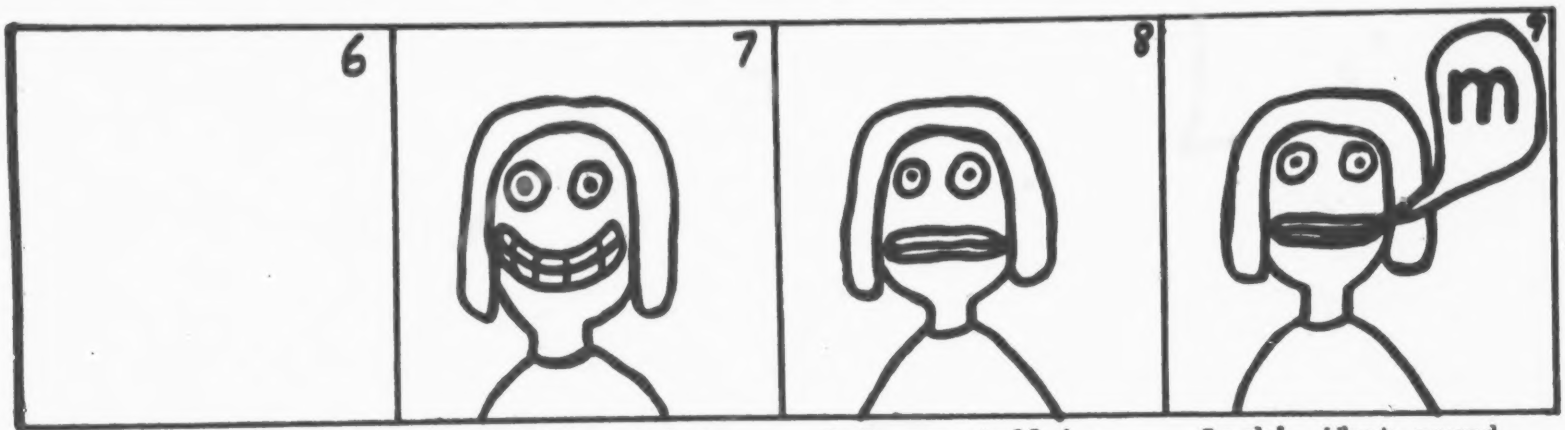
Blending these two factors together (the letter as a snake) yields a pure case of simultaneous occurrence of content and context. The snake's widely understood plastic qualities add a measure of plausibility to his performance of imitating letter figures.

A third example of the simultaneous and plausible relation between content and context is seen in Figure 4. Here the context may be described as the simulated role of teacher. The child at the machine is asked to direct the image of another child (on the projector screen) in saying the letter sounds.

Trying to plausibly and simultaneously relate a context to some content can be an exercise in mental gymnastics. The question posed by such an orientation is this: given that I have to teach letter sounds (or any other content), what normally occurring circumstance associated with this context is also interesting? Programers, developers, and researchers faced with high production schedules and limited time would do well to consider the opposite extreme, a category of lessons in which content and context have little to do with each other and are structurally distinct. The Lump Story, Figure 5, is an example of a far larger category of lessons where skill context (letter image) and motivational context (story) occur as separate and unrelated events.

The letter the child looks at and the content responses he makes are only temporarily related to the story. A skill event (oral sound response to letter image) is followed by a story event, etc. in the fashion of television programing where commercial and program follow each other as separate events, related only by time and other physical projection factors.

In terms of workability lessons, such as the Lump Story secure looking, listening and response-production behavior just as well as the

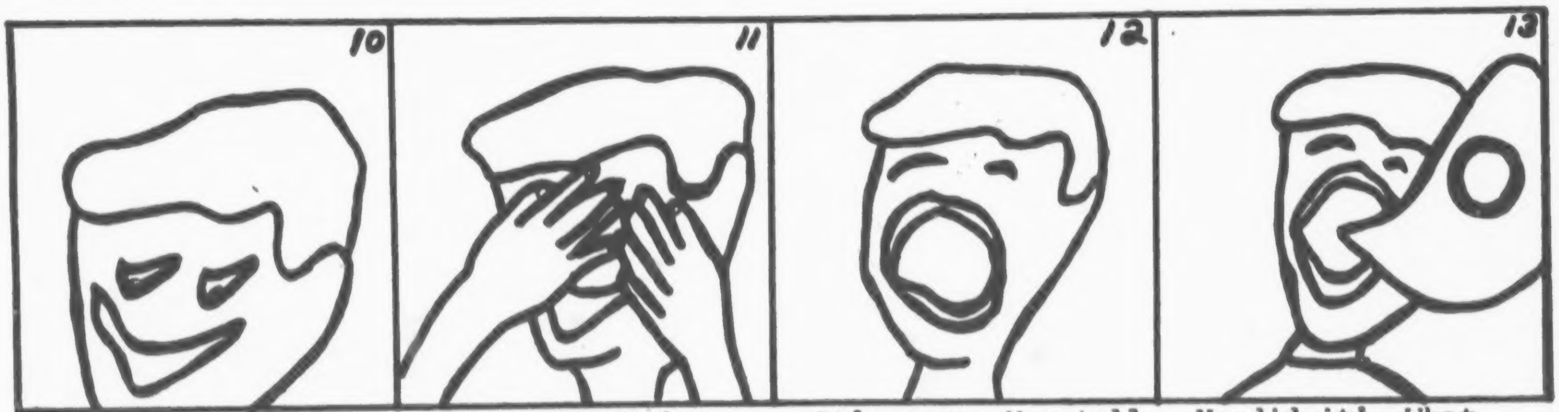


Now you're going to show some kids how to say /o/ and /m/.

Tell this girl to close her lips, say close your lips...

O.K. now tell her to say /m/.......

Look! What sound is she making?.../m/ what letter is coming out of her mouth? ... /m/

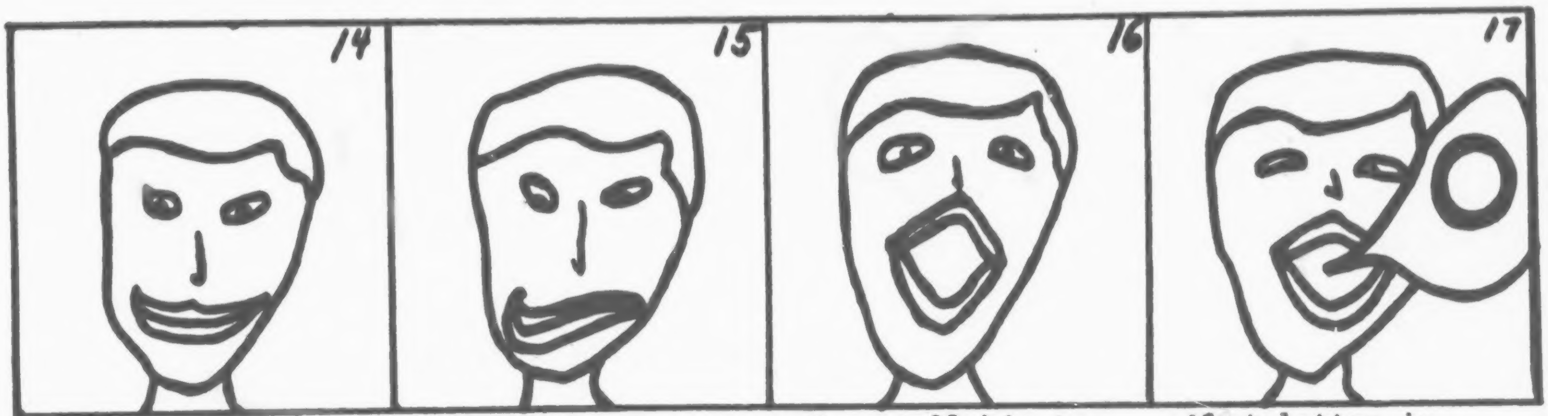


Now tell this boy to open his mouth. Say open your mouth.....

Oh! Oh! he's bashful, say, open up... say, aw, come on...

It's open. Now tell him to say /o/.....

He did it! What letter is that coming out of his mouth?.../o/



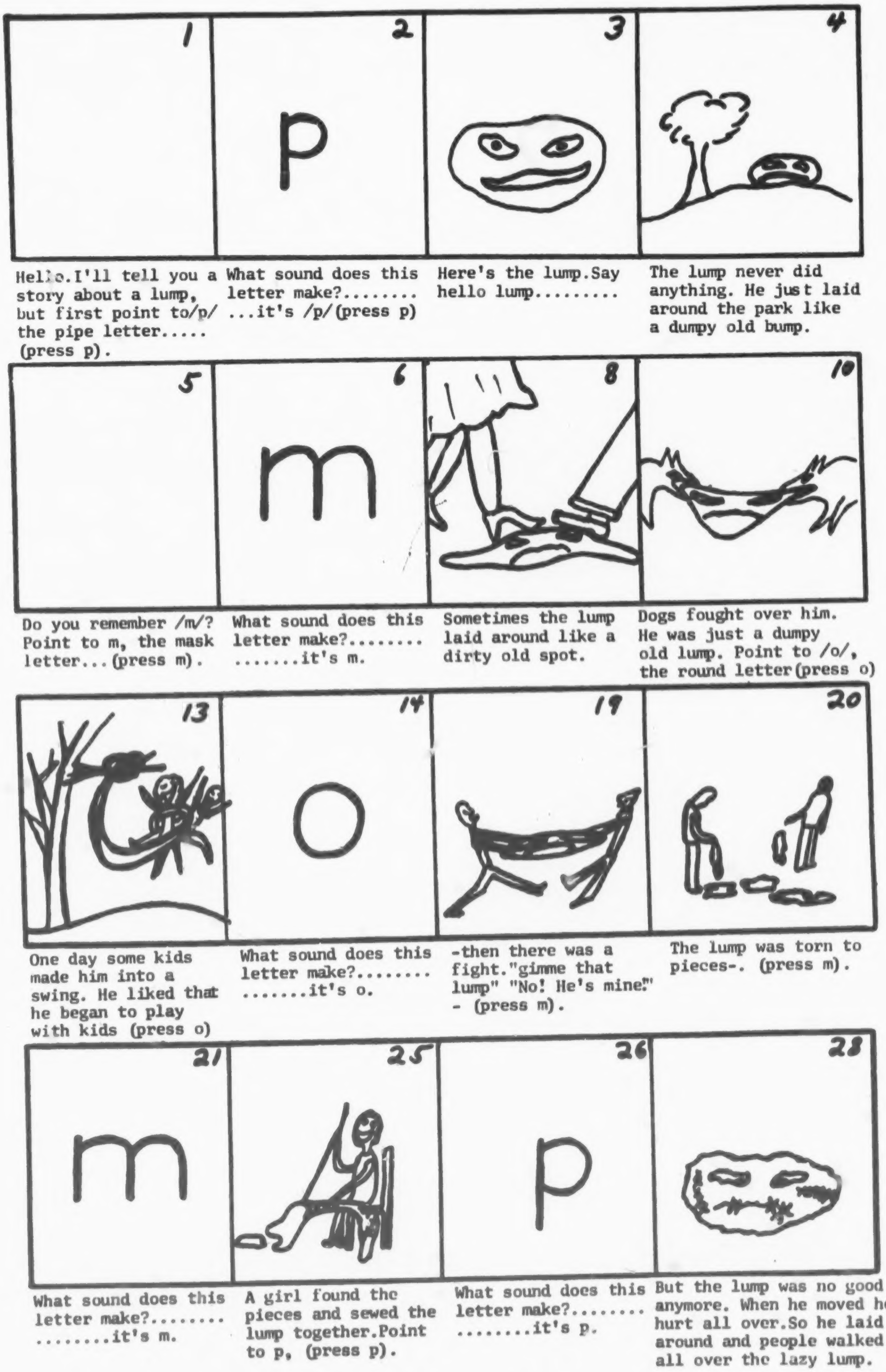
Tell this boy to say /o/....

Oh boy! he doesn't know what you mean. Tell him to open his mouth...

Now, tell him to say /o/....

What letter is coming out of his mouth?.../o/.

FIGURE 4. Simulated role of teacher. An example of culturally normal associations between content (saying letter sounds) and context (simulating the role of a teacher).



Hello.I'll tell you a story about a lump, but first point to/p/ the pipe letter..... (press p).

What sound does this letter make?........ ...it's /p/(press p)

Here's the lump.Say hello lump.........

The lump never did anything. He just laid around the park like a dumpy old bump.

Do you remember /m/? Point to m, the mask letter...(press m).

What sound does this letter make?........ ....it's m.

Sometimes the lump laid around like a dirty old spot.

Dogs fought over him. He was just a dumpy old lump. Point to /o/, the round letter(press o)

One day some kids made him into a swing. He liked that he began to play with kids (press o)

What sound does this letter make?........ ....it's o.

-then there was a fight."gimme that lump" "No! He's mine!" - (press m).

The lump was torn to pieces-. (press m).

What sound does this letter make?........ ....it's m.

A girl found the pieces and sewed the lump together.Point to p, (press p).

What sound does this letter make?........ ....it's p.

But the lump was no good anymore. When he moved he hurt all over.So he laid around and people walked all over the lazy lump.

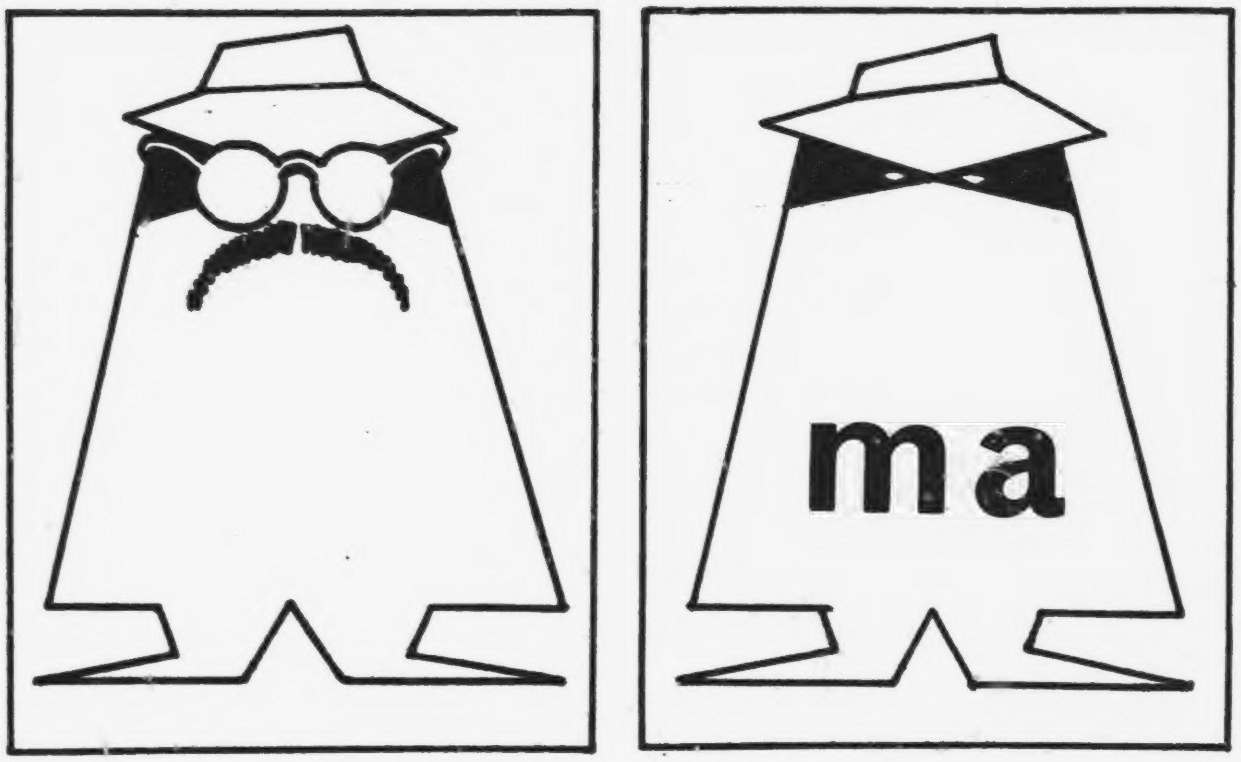
FIGURE 5. Lump Story. An example of discontinuous and separate relations between content (letter sounds) and context (story). The content is unrelated to the story.

snake lesson where the skill content and motivational context are simultaneous as opposed to separate events. When the plain letter image is displayed after a brief story sequence, the children do not turn away from the projector screen and engage in irrelevant activity unrelated to the lesson; they continue to look, listen and respond as attentively as during the story portion.

The technique of disassociating context from content requires a flexibility in our cultural orientation as teachers. The children have no problem with these lessons. Adults are another story. Visitors to our project often examine the lessons for plausible connections between context and content. This is the normal thing for them to do. Much TV advertising used to have, and still does, very plausible connections between product message and context. Yet, daily we see examples in which interesting TV commercials have only very tenuous connections between a minimal display of the product and some implicit message such as "buy it" on the one hand, and the surrounding context on the other. While not entirely separating the product from consumer-attraction techniques, some of the current TV ads precede the product with the more interesting context. A minimally plausible connection between the two usually occurs at the end of the commercial.

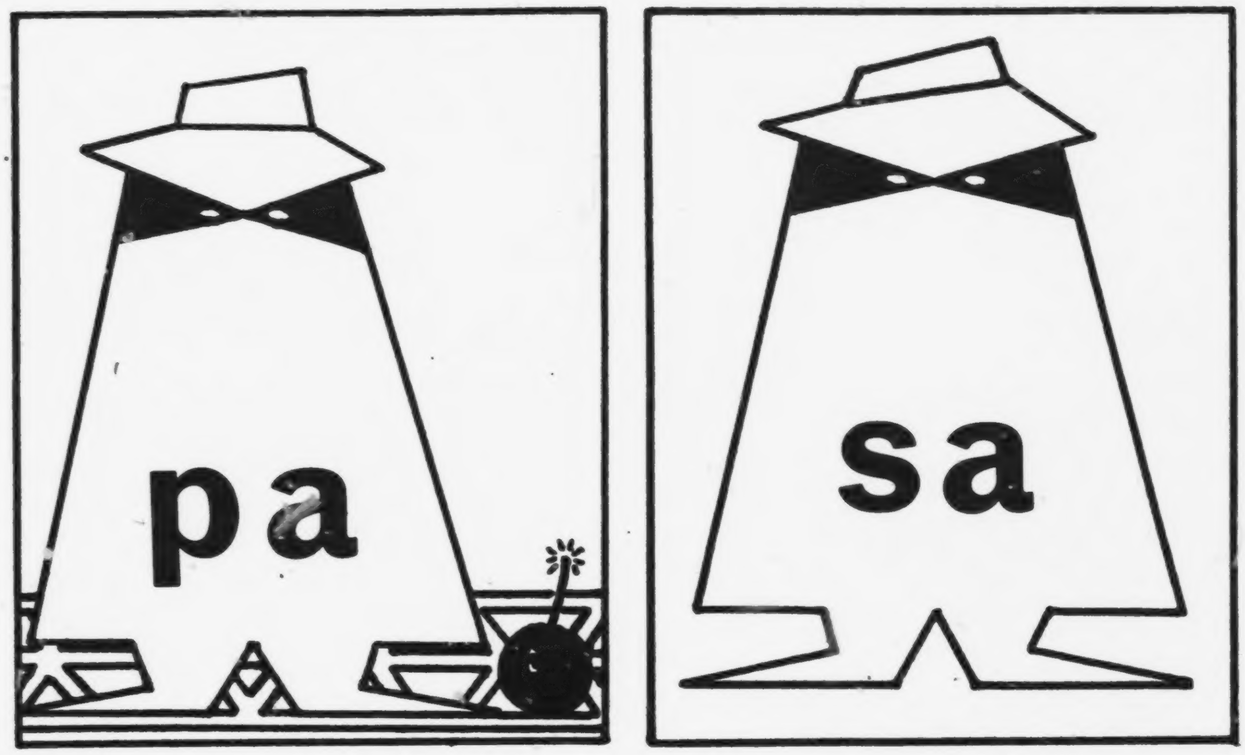
Between the extremes outlined above there is a third category of lessons in which a plausible connection between content and context is arbitrarily imposed. One simply invents or creates a culturally understandable relationship between the two . In the sample segments (Figures 6-10) the letter images and their sounds are used as labels and names for animals, characters and objects.

2



Here's a secret agent. He has a disguise on. You can't see his name. Let's take his disguise off and find out his name.

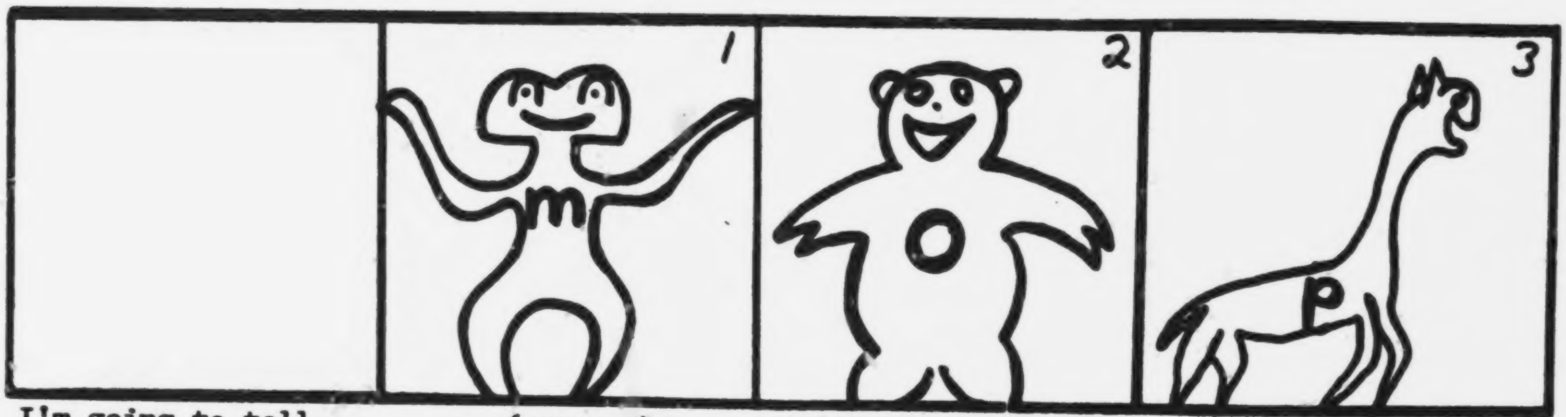
What's his name?.......... It's ma.



This secret agent found a bomb under that bridge. Who found that bomb?..... pa.

Here is our last secret agent. What is his name?. ....It's sa.

FIGURE 6. Secret Agents. An example of arbitrarily imposed relations between content (letter sounds) and context (character names). Letter sounds are used as character names.

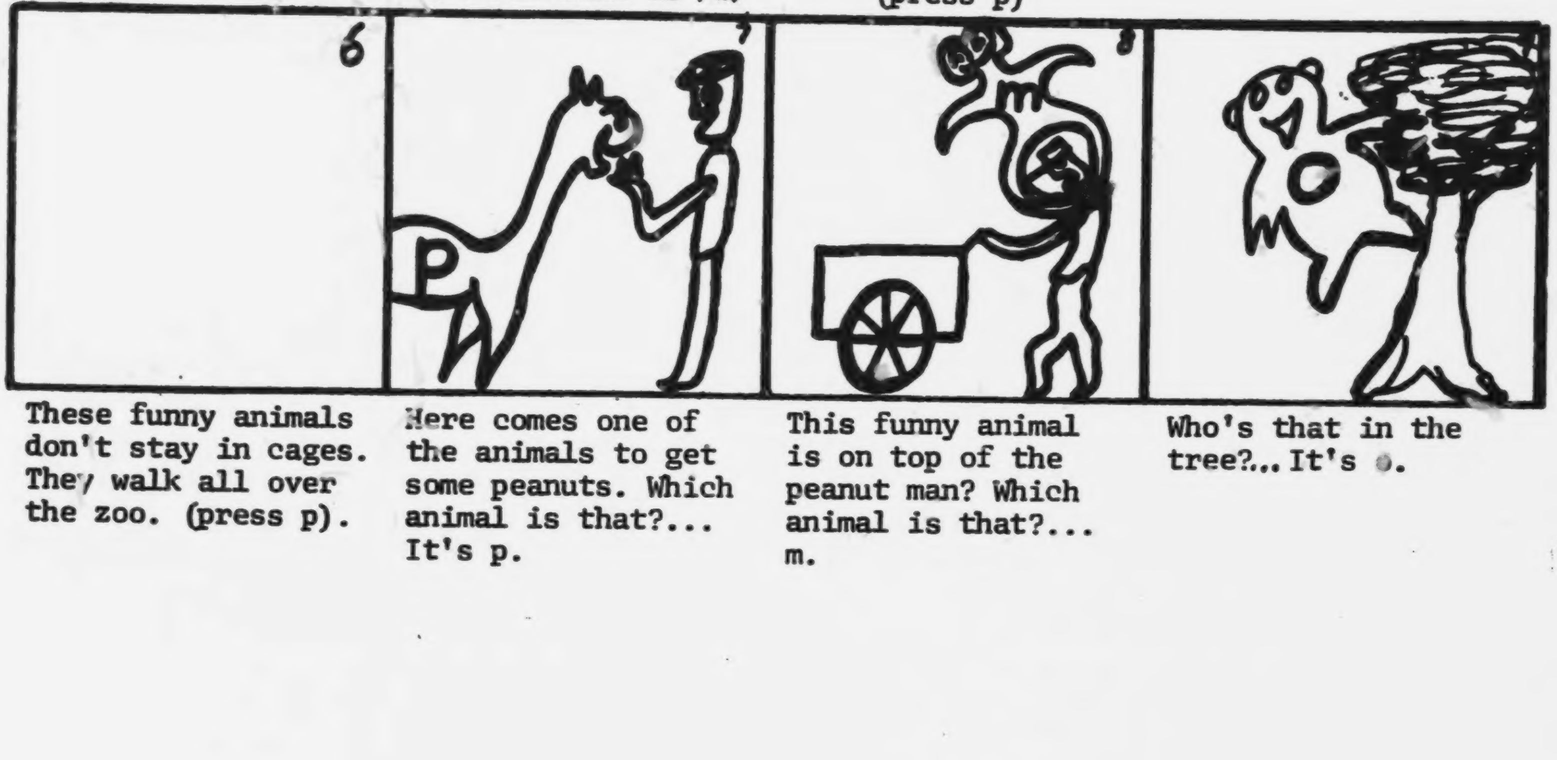


I'm going to tell you about some funny animals at the zoo. Did you ever go to the zoo?

(press m) Look at the letter on this animal. Is it /p/ or /m/?..It's /m/.-His name is /m/

(press o) Look at the letter on- Is it /o/ or /m/?.../o/.- Now point to /p/ (press p)

Look at the letter on--- Is it /o/ or /p/?..../p/.



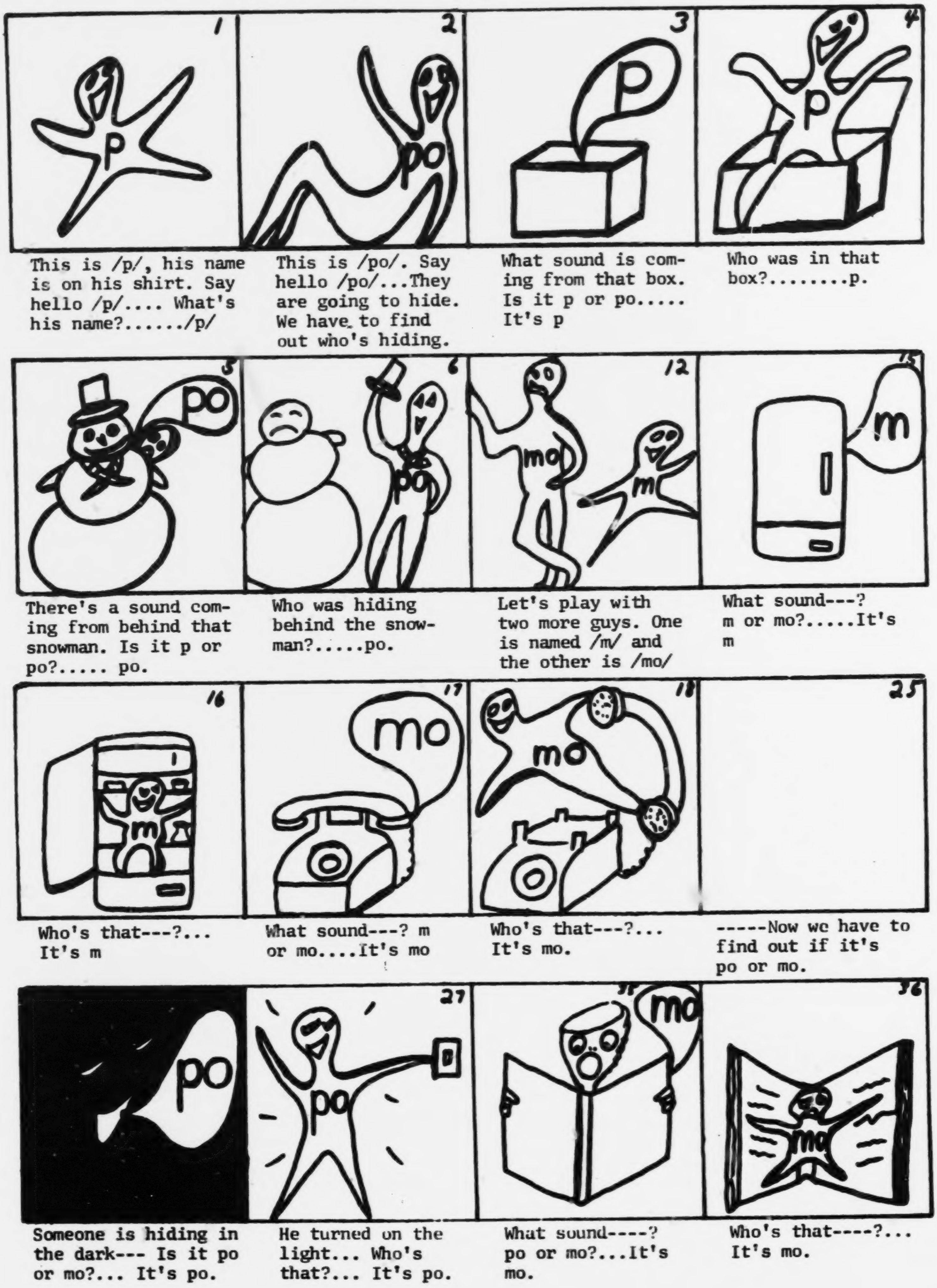
These funny animals don't stay in cages. They walk all over the zoo. (press p).

Here comes one of the animals to get some peanuts. Which animal is that?... It's p.

This funny animal is on top of the peanut man? Which animal is that?... m.

Who's that in the tree?... It's o.

FIGURE 7. Zoo Story. Arbitrary relations.



This is /p/, his name is on his shirt. Say hello /p/.... What's his name?....../p/

This is /po/. Say hello /po/...They are going to hide. We have to find out who's hiding.

What sound is coming from that box. Is it p or po..... It's p

Who was in that box?........p.

There's a sound coming from behind that snowman. Is it p or po?..... po.

Who was hiding behind the snowman?.....po.

Let's play with two more guys. One is named /m/ and the other is /mo/

What sound---? m or mo?.....It's m

Who's that---?... It's m

What sound---? m or mo....It's mo

Who's that---?... It's mo.

-----Now we have to find out if it's po or mo.

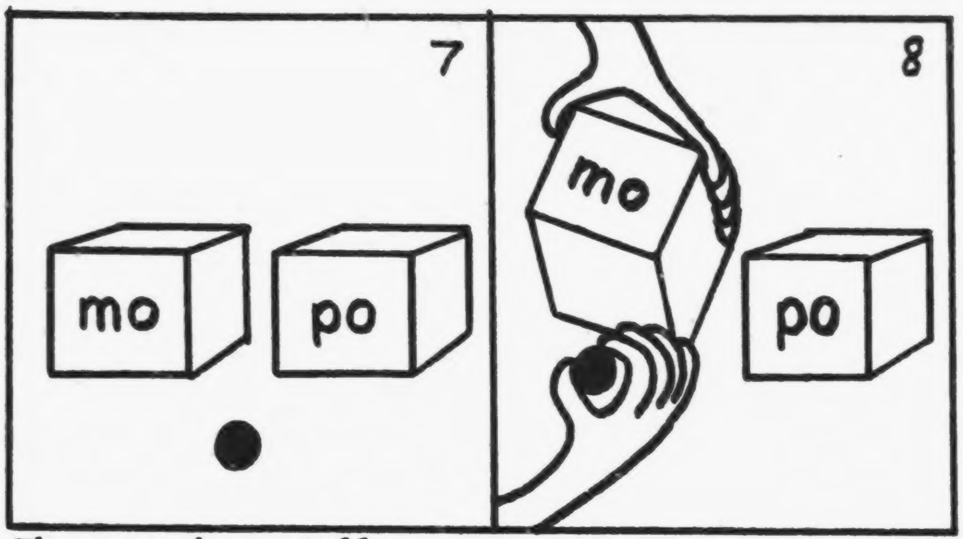
Someone is hiding in the dark--- Is it po or mo?... It's po.

He turned on the light... Who's that?... It's po.

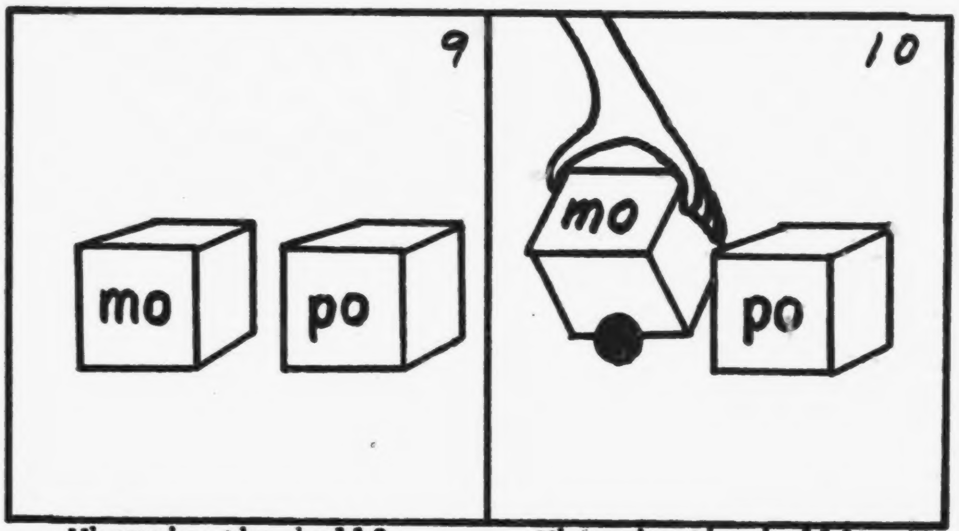
What sound----? po or mo?...It's mo.

Who's that----?... It's mo.

FIGURE 8. Hide and Seek. Arbitrary relations.



The game is to tell which box the ball is under.



Where's the ball? Under the mo or the po box?................ Under the mo box.

Where's the ball? ....it's under the mo box.

FIGURE 9. The Old Ball in The Box Game. Arbitrary relation between content and context. Letter sounds are used to name objects.

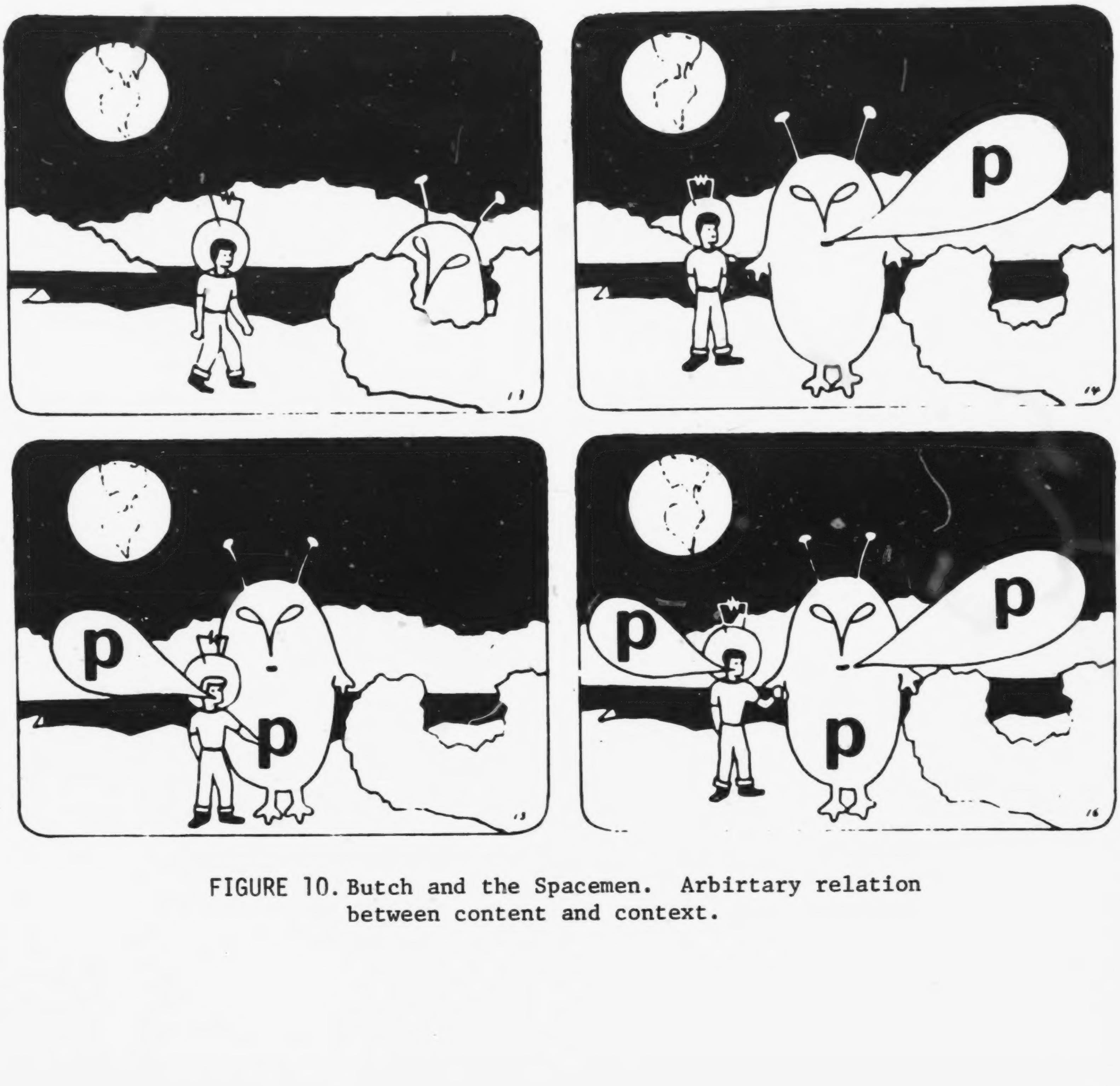


FIGURE 10. Butch and the Spacemen. Arbirtary relation between content and context.

Originally we faced the problem of producing motivational lessons armed only with the normal, cultural assumption that the parts of a message are usually plausibly related. Our early lessons all reflected culturally meaningful connections between the content we were teaching and the context in which it was placed. The production schedule, on the one hand, and the motivational requirements, on the other forced an expansion of the framework to include both the separation and discontinuity of content and context, presented above. This broader framework opened up a new, seemingly unlimited, reservoir of lesson contexts. Moreover, we now know that the requirements for developing and using frameworks to derive sequences of skill-content are sufficiently different from those needed to derive motivational contexts as to warrant a clear division of labor. We could easily envision production teams of skill-content specialists working on content problems side by side with motivational specialists working out context problems. At this point it is our impression that more research and development effort has been devoted to questions of skill-content than to questions of motivational treatment. In the field of programed instruction there are only occasional references to both the need and possibilities of motivationally treated lessons. Yet, we hear more than occasional reports that the children lack motivation and are bored.

A principal objective in this project has been the development of a structured skill sequence; that is, to develop analytical reading skills in the child. Separating content from context we can shift the objective of programing from skill content to motivational context. The objective of testing and revising can become the context of lessons, not their content. By applying the programing model of development to lesson contexts it is possible to systematically build up a reservoir of motivational treatments in much the same manner that knowledge is being amassed with respect to sequencing of content and skills. By drawing upon such a reservoir of motivational treatments it is conceivable that in time such typical problems as boredom and diffused attention could cease to be persistent problems for large numbers of children.

B. Behavioral Strategies

As these lessons were developed many words and pictures were spoken to the children. Hundreds of these stimuli (words and pictures) were discarded as unworkable. Our success hinged on finding (1) precisely those words and pictures and (2) precisely that arrangement of words and pictures which would yield the responses we were seeking from the children. As each revision yielded better results the proper words and pictures and their proper arrangement began to crystallize. Ultimately, we were able to define the structure of the audio-visual language which was effective in shaping each skill. These structures are diagramed below in the form of stimulus-response paradigms.

The structure of each stimulus is determined by what is said and shown to the child and is denoted by S. What the child usually does in response to S is denoted by R. A behavioral structure can be thought of as a rule which defines the way in which words and pictures are arranged in order to teach a wide variety of content.

The structure of an echo is useful not only in teaching letter sounds, but also in generally naming objects related to a wide range of content.

Echo Rule

Teacher: "this is______, you say ______."

Student: says "_____."

In paradigm form the echo rules look like the following:

$S \longrightarrow R$

Machine says "This is ___, you say ___"	Child says "_____"

Any object or attribute name can be substituted for the place holder (_____).

$S \longrightarrow R$

(picture of two rabbits) machine says "here is a picture of two rabbits. you say two rabbits."	Child looks at picture and says, "two rabbits"

At several places in the program the echo structure is used to teach such varied content as

1. Machine parts:

$S \longrightarrow R$

(photo of typewriter) "This is a picture of your typewriter. Say typewriter."	Child says, "typewriter."

2. Single letter sounds:

$$S \longrightarrow R$$

S	R
-m-	
"The sound this letter makes is mm. Say mm."	Child says "m"

3. Unitary response to two letters:

$$S \longrightarrow R$$

S	R
-ma-	
"This is ma, say ma."	Child says "ma."

The rule for teaching visual matching behavior is similar to an echo rule in that the model to guide the child's correctness is immediately provided. Unlike the echo, the model remains available during the child's response.

$$S \longrightarrow R$$

S	R
-m-	-m-
"Here is my letter. Point to the letter on your button that's just like mine."	Child points to m button

The visual stimulus (letter m) remains available while the child searches for the same letter-button. The matching rule can be used in a variety of ways.

$S^1 \longrightarrow$	R^1	$S^2 \longrightarrow$	R^2
"Look down at your typewriter. Watch, I'll show you what I mean."	Child looks and listens.	(Machine shows photo of typewriter.) "Here is a picture of your typewriter. Now, do you see it?"	Child looks at photo and then looks down at typewriter in front of him.

The matching rule in the above example ($S^2 \longrightarrow R^2$) is used as feedback for the instruction in the first unit ($S^1 \longrightarrow R^1$) . Most of the S-R paradigms, by means of which increasingly complex responses are taught in the program, are actually combinations of two or more simpler S-R units. The combining of two or more S-R units in a supportive fashion is a fundamental structural feature of the program. In the following paradigm three units are linked together in a supportive chain. Each unit in the chain plays a special role in helping the child to respond correctly.

Indicating Chain

$S^1 \longrightarrow$	R^1	$S^2 \longrightarrow$	R^2	$S^3 \longrightarrow$	R^3
"Point to o."	Child points to one of several buttons.	"o is the round letter."	Child confirms or revises choice.	"Press o."	Child presses o button

The first unit ($S^1 \longrightarrow R^1$) calls for a pointing response. The second unit ($S^2 \longrightarrow R^2$) gives the child information to either confirm or revise his choice. The third unit ($S^3 \longrightarrow R^3$) calls for a pressing response to the same letter. The strategic importance of this chain lies in the corrective value of the second unit ($S^2 \longrightarrow R^2$). If the child points to the wrong letter (R^1), the feedback which follows (S^2) gives him additional information to correct his pointing response. A few seconds later the child is given another opportunity to use this feedback (S^3) by means of a pressing response. In the S-R chains which follow this same supportive structure is used to teach other skills.

Oral Selection Chain

$S^1 \longrightarrow$	R^1	$S^2 \longrightarrow$	R^2	$S^3 \longrightarrow$	R^3
-m- "Is this mm or o?	Child selects and says one of the sounds.	"It's mm".	Child listens to feedback.	-m- "Say the sound."	Child says "it's mm."

Again the same content (letter m) is presented twice (S^1 and S^3) and there are two opportunities to respond to the same content (R^1 and R^3). These two opportunities are linked together by corrective feedback (S^2).

Oral Construction Chain

$S^1 \longrightarrow$	R^1	$S^2 \longrightarrow$	R^2	$S^3 \longrightarrow$	R^3
-m- "Say the sound."	Child produces or doesn't produce a sound.	"It's mm."	Child listens to feedback.	-m- "Say the sound."	Child says "it's mm."

Indicating Chain

$S^1 \longrightarrow$	R^1	$S^2 \longrightarrow$	R^2	$S^3 \longrightarrow$	R^3
"Point to mo."	Child points to one of several buttons.	"mo is the one with m and o."	Child confirms or revises choice.	"Press mo."	Child presses mo button.

The first unit, ($S^1 \longrightarrow R^1$), calls for a pointing response. The second unit, ($S^2 \longrightarrow R^2$), gives the child information to either confirm or revise.

These supportive chains, containing two opportunities to respond correctly to the same content and linked together by corrective feedback, can be generalized to the following form:

$S^1 \longrightarrow$	R^1	$S^2 \longrightarrow$	R^2	$S^3 \longrightarrow$	R^3
"Do x."	Child responds or doesn't respond.	"x is done this way."	Child listens to how x is done.	"Do x."	Child does x.

Assuming that this is a new experience for the child, it is doubtful that the first active response ($S^1 \longrightarrow R^1$) will be correct since the child is faced with performing in a new manner. However, the correctness of the second active response ($S^3 \longrightarrow R^3$) is more certain. The child's attention to the feedback, consisting of what he should have done ($S^2 \longrightarrow R^2$), increases the probability of correctness on the second active response ($S^3 \longrightarrow R^3$). The success we have had with this chain suggests that an instructional sequence should be designed so that a doubtful response (of low probability) is followed by a more certain response of higher probability. The role of feedback (S^2) is to make the correctness of the second active response (R^3) more probable. A more elaborate exposition of all the response chains defined by the program is presented in Appendix A.

These structures or rules define a method of teaching a wide variety of content: for example, the association of number-names (like "two") with numerals (2), color-names with colors, object-names with objects, or descriptive phrases with the spatial relationship of objects (next to, under, etc.). All of this content requires the production of oral responses to graphic images or of indicating responses to the language associated with such images. Whether they are letters, numerals, colors, objects, or objects in relative position, the underlying behavior is, in most instances, almost identical.

C. Performance Aids in Teaching (PAT)

Job performance aids include a variety of items ranging from simple manuals to sophisticated electronic equipment. They offer a potential means of aiding work performance so that job requirements may be reduced, thereby permitting the use of workers with less natural capacity, skills and training. Chalupsky (1967) reviewed research and application in the use of job performance aids, concentrating on two occupational areas: electronic assembly and nursing patient care. The results of his study showed that, depending upon their design and usage, job performance aids can compensate for lack of training and experience, improve job quality, and increase labor productivity. Where tasks are repetitive, the aids decline in importance. Where jobs are complex and involve infrequently performed operations, the aids are most effective.

The ERE can be thought of as an aid in the performance of teaching tasks. Once the ERE or any other equipment has been programed to show pictures and say words in a coordinated fashion, a teacher can step outside her normal instructional role of presenting information and freely observe the interaction between a child and the teaching machine. The machine also helps the teacher in her presentation of lessons because it plays back or presents audiovisual stimuli to the child.

One of our chief concerns in this project was the dissemination of validated lessons. ERE lessons require an ERE machine for proper playback, and our lessons could not be easily disseminated due to this requirement for special playback features. However, it is possible to translate machine lessons into other forms. In the following discussion we shall describe the rationale for a wide variety of performance aids in teaching (PAT) and specify one such aid which we developed for its dissemination advantages.

PAT is a concept of materials engineering which has considerable import for the utilization of parents, tutors, and other paraprofessionals, as well as children, in performing direct teaching functions. In current practice the teacher plans what he will say and show to students, occasionally utilizing official curriculum bulletins and commercially produced teacher manuals. Most manuals and bulletins are similar to the teacher's approximate plans, providing a general framework which determines the broad category of stimuli which are to be presented to and elicited from students. Such aids are descriptions of what should be done rather than prescriptions of what to do. They are passive as opposed to active in the degree to which they guide an instructional agent's performance.

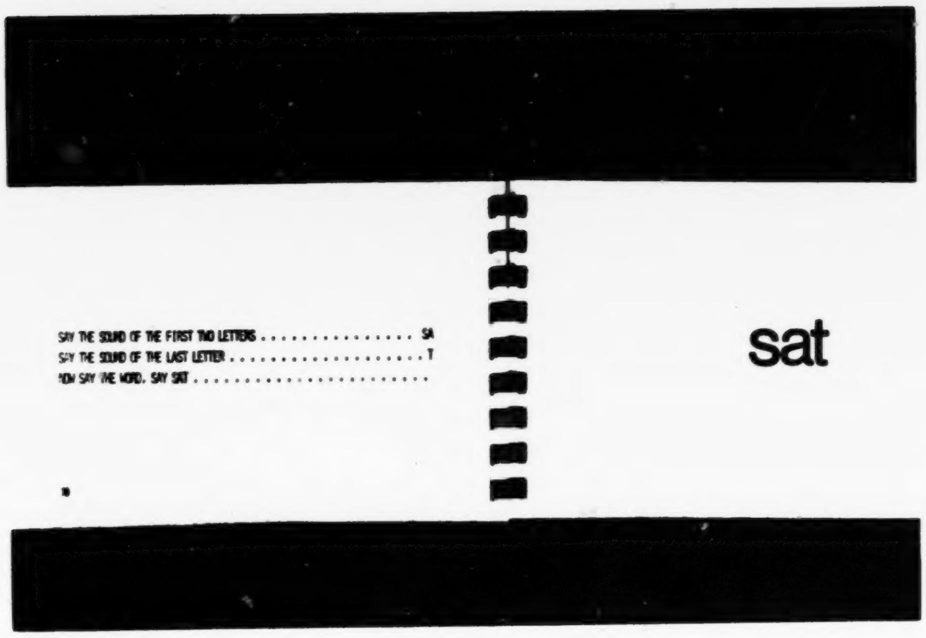
Machine programing demands precise specification of every visual and verbal stimulus to be presented to the child. Unlike teacher planning which can be, and is often, approximate, one cannot tell a machine approximately what to do. It is necessary for programers to produce in written form an exhaustive script of what the machine must actually do at every step in the lesson. As a result, programers, working under such rigorous planning demands, leave written, precise records of highly specific instructional events (Silberman, 1964). These records can then be translated into a variety of forms.

PAT materials differ from such aids as teacher plans, commercial manuals, and curriculum bulletins by attempting to specify every word and image to be said and shown to the child and the sequence in which these events are to occur. PAT also specifies in its sequenced script when the teacher is to pause for the student's reaction and what he is to say after each response. Although it is impossible to specify every event which occurs in an instructional interaction, PAT is distinguished by the degree to which its specifications tend to be exhaustive of all the events necessary for a given population.

A close analogy to PAT is the actor's script in a theatrical rehearsal. The polished performance of an actor is the end product of a series of rehearsals in which the script plays a crucial role. The script is relied upon almost totally in the beginning stages of role-shaping. With continued repetitions the actor internalizes the role, and the script declines in importance. The script is essentially a training aid. Like the actor, it can be anticipated that once an instructional agent has used the PAT several times, he will internalize the sequence structure and can then operate efficiently using a blackboard and other materials in small group settings. For the theatre the script is a natural part of the rehearsal program. For education the script (performance aid) has still to become an explicit part of the training program.

PAT may take a variety of forms. One such form which interests us for its economical and flexible-use benefits is the book-form shown in Figure 11. This form was used in presenting lessons 35 to 62 to the kindergarten sample. The instructional agent (teachers, tutor, paraprofessional or parent) reads the left page while the child looks at the right page. The dots are cues for the agent to pause for the child's response. After the child's response or a specified number of seconds, whichever comes first, the agent continues by presenting the feedback and turning the page.

PAT can be applied to a wide range of curriculum content and materials. For example, a storybook can be analyzed for the content relevant to some curriculum objective, and suitable PATS can then be designed. After the



SAY THE SOUND OF THE FIRST TWO LETTERS . . . . SA
SAY THE SOUND OF THE LAST LETTER . . . . T
NOW SAY THE WORD. SAY SAT . . . .

sat

FIGURE 11. Example of scripts in book form (PAT). Scripts were used in presenting lessons 34-62 to one experimental group.

story is read to a child the PAT guides the agent in presenting additional information to the child and/or eliciting additional responses. PAT can thus be incorporated into the design of a sequence of stimuli or can be applied ad hoc to traditionally designed materials. Its essential feature is to actively prescribe all necessary words and images which an agent may need in eliciting correct responses from students. Since PAT materials prescribe what to do, naive instructional agents can effectively perform direct instruction with children almost at the beginning stages of training. PAT materials can contribute to accuracy and consistency in shaping the behavior of instructional agents. Agents exposed to loosely structured training programs are more likely to display variable job performance. However, it is our impression that agents exposed initially to highly structured scripts will internalize the sequence embodied in the scripts, using its salient features to guide their future job performance.

References

Chall, J. Learning to read; the great debate. New York: McGraw Hill, 1967.

Chalupsky, A.B. Exploratory study of job performance aids and their potential impact upon training requirements and manpower utilization. U.S. Dept. of Labor, Contract #81-05-67,06, 1967.

Coleman, E. B. Collecting a data base for an educational technology; evolving a psycholinguistic program. Inglewood, California: Southwest Regional Laboratory, 1967.

Morphett, M. and Washburne, C. "When should children begin to read?" Elementary School Journal, 1931, 31, 496-503.

Chapter V. Validation Studies

These studies, using the most effective version of the program, attempted to answer the question: "How well do the lessons accomplish their objectives and at what cost in terms of time?" The study documents the levels of skill mastery as measured by criterion tests administered to the children. The time factor is reported accurately in Chapter VI. An additional question investigated by the study was: "How well do the lessons work in another similar setting administered by different personnel?" This question is answered by criterion test data for first grade children from another school district.

A. Program Administration

The program was tested in kindergarten at P.S. 175 in Harlem and in first grade at P.S. 21 in Brooklyn throughout the entire 1967-68 school year. The 62 7-minute lessons were designed to teach the analysis and synthesis of three-letter words. At P.S. 175 these were divided into 34 machine lessons to be presented by the ERE to one child at a time who would work alone in a 4' x 4' x 8' booth; and 28 tutorial lessons presented in the same booth by one experimenter using specially designed tutorial scripts in book form. The validation test at P.S. 21 consisted of 62 machine lessons with tutorial sessions serving as branching options for those children in need of additional help.

In addition to the 62 main sequence lessons, approximately 18 machine lessons were specially designed as branches in which one letter was coupled with a second letter. Thus, children showing strength in one letter and weakness in the other could be assigned to a specific lesson in which the strong letter was contrasted with the weaker one. For example, if a child showed weakness in saying the sound for the letter m but was strong in responding correctly to the letter O, then he was assigned to a branch lesson which couples response opportunities to both m and o without the presence of other letters. Other branching strategies consisted of repeating lessons at the same level or reassignment to lessons at lower levels.

B. Procedures

The children at P.S. 175 were assigned to one of two kindergartens on the basis of overall class size. During school registration the children were alternately assigned to one of two kindergarten teachers; i.e., if one child was assigned to teacher 1, then the next child to register was assigned to teacher 2, and so on.

In the experimental kindergarten sample all the children (34) were taken from the morning and afternoon classes of the same kindergarten teacher, while the second kindergarten teacher's classes were designated as a control group. The school contains only two regular kindergarten classes, both following the New York City readiness program with the addition of The Kindergarten Book of the Stern Structural Program. In the first grade sample all 33 of the experimental children were taken from two different classes. Both first grades followed a basal reader program. No controls were designated for the first grade sample. (The first grade test was an additional data gathering opportunity that became available to our project and was not anticipated in our planning. Hence the first grade data lack adequate controls, but they are useful in other ways.) All children were pretested in October to determine their prior knowledge of the skills being taught in the program. The single letter portion of the criterion test was administered before starting the program. The trigram portion of the pretest was administered to each child in January. In addition to skill pretesting, an individual I.Q. test was administered to the experimental kindergarten children in October and early November. After the pretesting the children were taken individually from their classroom each day for one lesson which lasted approximately seven minutes and was presented in the learning booth. As the child responded, errors, latencies*, and behavior irrelevant to the lesson were observed. These data served as a basis for the next lesson assignment. Error rates greater than 10% and/or latencies greater than three seconds served as a basis for branching assignments. A child who exhibited 90% or higher correct responding within a response latency of approximately three seconds was assigned to the next higher skill lesson. Children who responded correctly, but with response latencies greater than three seconds, were also branched accordingly until the response latency became shorter. Immediately after completion of the program the criterion test was again administered. For children completing oral trigrams, a transfer test was administered on the day following the criterion posttest.

C. Results

1. Criterion Pretests--Kindergarten (Table 1): In pretesting, the

---

*latency refers to how long a child takes to respond. If he responds immediately after a question is asked his latency is short. If he needs several seconds to think of an answer his latency is longer.

experimental kindergarten children achieved a mean of 85 on the I.Q. test, ranging from a low of 51 to a high of 103. The mean pretest score for knowledge of letter sounds and trigrams was zero for both kindergartens. This score also reflects letter-name knowledge.

2. Criterion Posttest--Experimental Kindergarten (Table 1): Only eight of the 34 children failed to obtain 100% mastery of single sounds. Of these eight, only five fell at or below the 66% level of mastery. As the program progressed twelve children were highly variable in attendance. Five of these children eventually left the school (Students #25, 26, 27, 28, 31). The remaining seven continued showing variable attendance patterns which considerably slowed their progress into higher level blending skills (Student #18, 19, 20, 21, 22, 23, 33). Six of the attendance problem children eventually progressed into the bigram blending skills. Only one child fell below 66% mastery at this level. Continued poor attendance, however, precluded further progress into trigram blending.

Twenty-two of the experimental kindergarten children showed stable attendance patterns. Sixteen of these were able to complete the entire program while the progress of six children was retarded by lack of mastery at lower levels. For those sixteen kindergarten children completing the oral trigrams, none fell below the 85% mastery level, while ten achieved 100% mastery. Of the six children showing stable attendance but slow progress, two were dropped from the program for immaturity (Student #29, 30) while four received intensive branching and highly individualized treatments (Student #17, 24, 32, 34).

3. Transfer Test--Experimental Kindergarten (Table 1): Fifteen children completed the abstract transfer test. One of the sixteen kindergarten children completing the oral trigrams was not available for transfer testing.

Four children displayed no evidence of transferring the blending skill to abstract, nonsense trigrams. Eleven children could synthesize (blend) an average of three out of seven abstract trigrams.

4. Criterion Posttest--Control Kindergarten (Table 2): In June, 1968, the same criterion test used for the experimental class was administered individually to the kindergarten control children. It should be noted that the control class followed the New York City readiness program with the addition of the Kindergarten Book of the Stern Structural Reading program. Eight of the control children showed knowledge of at least one of the sounds being taught in the program. One child displayed considerable evidence of higher order blending skills, indicating special tutoring outside the regular classroom program. Most of the controls showed little or no knowledge of letter sounds and blending skills. (Table 2 also includes pretest data for the control kindergarten.)

5. Delayed Posttest--Experimental Kindergarten (Table 3): A retention test, identical to the criterion test, was administered to fifteen of the experimental kindergarten children after a delay period ranging from twenty to ninety-eight days after completion of the program. The remaining children were not tested due to the widespread absenteeism during the closing days of the school year. The retention test delay period varied because the children completed the program at different times but were tested simultaneously. This happened since there was a fixed date for the completion of the project's work.

Retention was greater for single sounds than for higher blending skills. Within the blending skills retention was greater for bigrams than for trigrams, but both bigram and trigram blending showed a similar retention level of about

68% as opposed to 90% of single sounds. It should be remembered that while loss was greater for the higher order blending skills, it is precisely these skills which were used less in the experimental sessions and not at all in the regular classroom setting. The child's only use of the blending skills was during the 7-minute experimental session each day. The higher retention levels for single sounds reflects the greater use made of this skill in the program as well as some opportunity to use this skill in the regular kindergarten program. This is so because of the use of the Stern kindergarten book in the classroom.

6. Pretest, Posttest and Transfer Test--Experimental First Grade (Table 4): Only trigram test scores are reported for the first grade children. Pre-posttest differences for single letter sounds were essentially the same as those reflected in the kindergarten data. However, the first grade children showed greater knowledge of trigrams in pretesting. While nineteen children knew none of the trigrams in pretesting, fourteen knew an average of two of the seven trigrams.

Of the 33 first graders, only one child scored below 85% mastery level on the posttest, while 32 recorded 100% mastery. The transfer test scores for the first graders are similar to those for the kindergarten population. Nine children displayed no transfer evidence, while the remaining 24 displayed evidence of abstract blending for three nonsense trigrams.

D. Analysis of Responses Testing for Transfer to Nonsense Trigrams

The "sounding out" or blending of phonetically regular 3-letter words is a complex skill involving several distinct component behaviors. We concluded that in order to blend the sounds represented in a trigram, the child must make an ordered, oral synthesis of the sounds represented by the letters

Table 1

Criterion Pretest and Posttest Scores in Percent for Each of Three Skill Levels Experimental Kindergarten

Student No.	Pretest				Immediate Post Test				Transfer
	Oral Single Sounds	Oral Bigrams	Oral Trigrams	Mean	Oral Single Sounds	Oral Bigrams	Oral Trigrams	Mean	Oral Abstract Trigrams
1	0	-	0	0	100	83	85	87	14
2	0	-	0	0	100	66	85	87	14
3	0	-	0	0	100	100	100	100	0
4	0	-	0	0	100	66	85	84	28
5	0	-	0	0	100	66	85	84	0
6	0	-	0	0	100	100	100	100	48
7	17	-	0	9	100	100	100	100	0
8	0	-	0	0	100	100	100	100	14
9	0	-	0	0	100	100	100	100	71
10	10	-	0	5	100	100	100	100	71
11	0	-	0	0	100	100	100	100	85
12	0	-	0	0	100	100	100	100	43
13	0	-	0	0	100	100	100	100	0
14	0	-	0	0	100	100	100	100	28
15	0	-	0	0	100	66	85	84	43
16	0	-	0	0	100	100	100	100	-
17	0	-	0	0	83	100	-	92	-
18	0	-	0	0	100	50	-	75	-
19	0	-	0	0	100	100	-	100	-
20	17	-	0	9	100	66	-	83	-
21	0	-	0	0	100	66	-	83	-
22	0	-	0	0	66	100	-	83	-
23	0	-	0	0	100	66	-	83	-
24	0	-	0	0	100	66	-	83	-
25	0	-	0	0	0	-	-	0	-
26	0	-	0	0	100	-	-	100	-
27	0	-	0	0	66	-	-	66	-
28	0	-	0	0	33	-	-	33	-
29	0	-	0	0	33	-	-	33	-
30	0	-	0	0	33	-	-	33	-
31	0	-	0	0	100	-	-	100	-
32	0	-	0	0	50	-	-	50	-
33	0	-	0	0	100	-	-	100	-
34	0	-	0	0	100	-	-	100	-
Median	*0*	-	*0*	-	*100*	*100*	*100*	-	*28*

Table 2

Criterion Pretest and Posttest Scores in Percent for Each of Three Skill Levels
Control Kindergarten

	Pretest				Immediate Post Test			
Student Number	Oral Single Sounds	Oral Bigram Blending	Oral Trigram Blending	Mean	Oral Single Sounds	Oral Bigram Blending	Oral Trigram Blending	Mean
35	0	-	0	0	0	0	0	0
36	0	-	0	0	0	0	0	0
37	0	-	0	0	0	0	0	0
38	0	-	0	0	0	0	0	0
39	0	-	0	0	0	0	0	0
40	0	-	0	0	33	0	0	11
41	0	-	0	0	0	0	0	0
42	-	-	0	-	0	0	0	0
43	0	-	0	0	17	0	0	6
44	0	-	0	0	17	17	14	16
45	-	-	-	-	83	66	71	73
46	0	-	0	0	17	0	0	6
47	0	-	0	0	17	0	0	6
48	0	-	0	0	0	0	0	0
49	-	-	-	-	0	0	0	0
50	0	-	0	0	0	0	0	0
51	0	-	0	0	17	0	0	6
52	0	-	0	0	0	0	0	0
53	0	-	0	0	0	0	0	0
54	0	-	0	0	0	0	0	0
55	0	-	0	0	17	0	0	6
56	0	-	0	0	-	-	-	-
57	0	-	0	0	-	-	-	-
58	0	-	0	0	-	-	-	-
59	0	-	0	0	-	-	-	-
60	0	-	0	0	-	-	-	-
Median	*0*	-	*0*	-	*0*	*0*	*0*	-

Table 3

Criterion Retention Scores in Percent for Each of Three Skill Levels Experimental Kindergarten

Student Number	Oral Single Sounds	Oral Bigram Blending	Oral Trigram Blending	Mean	Time Delay in Days
4	100	50	71	74	20
14	83	66	28	59	23
5	83	33	43	53	29
2	100	66	71	79	34
24	66	50	-	58	35
13	100	100	57	86	38
1	66	83	28	59	39
8	100	100	57	86	44
15	100	50	56	69	55
6	100	83	85	89	55
9	83	66	71	73	56
12	83	66	14	54	84
10	100	100	100	100	93
3	83	100	100	94	97
7	100	100	85	95	98
Mean	*90*	*74*	*62*	*75*	*53*

Table 4

Criterion Pretest and Posttest Scores in Percent for Oral Trigram Blending Skill

First Grade

Student No.	Pretest	Posttest	Transfer
1	0	85	14
2	28	100	85
3	0	100	0
4	14	100	43
5	57	100	14
6	0	100	14
7	0	100	28
8	43	100	71
9	14	100	28
10	28	100	71
11	28	100	0
12	0	85	0
13	0	100	18
14	14	100	28
15	0	85	0
16	0	100	28
17	0	85	28
18	14	100	0
19	0	100	28
20	0	85	100
21	14	100	100
22	0	43	0
23	0	100	0
24	100	100	43
25	0	85	28
26	14	85	14
27	0	85	14
28	28	100	28
29	0	100	28
30	0	100	0
31	43	100	43
32	0	85	0
33	0	100	71
mean	13	94	29

in the whole word. What is required is a left to right movement of the eyes together with a left to right oral mixing of the individual sounds. The separate subskills which were taught to the children in order to accomplish these tasks are divided into three main categories of training: (1) oral sound-symbol correspondence of individual letters, (2) letter order and (3) the perceptual set. The perceptual set was taught by training the child to perceive a 3-letter word as made up of two parts, i.e., the first two letters and the last letter. The children were taught to look at the word pat as made up of pa and t (pa t). The perceptual set contains within it two component behaviors: (1) perceiving the first two letters as one unit and the last letter as another unit and (2) perceiving these units in left to right order. Other perceptual sets are possible. In fact there appears to be competing positions as to which of two perceptual sets is most effective for beginning reading. Silberman (1964) and Bloomfield (1961) divide trigrams like pat into the following parts:

p at

Stern (1965), who provides us with our perceptual model, would divide the same trigrams in the following way:

pa t

Silberman tried both frameworks and got better results with Bloomfield's perceptual set, (p at). Stern's reasons for using pa t are quoted below:

> The parts into which a word is broken accord with natural speech. When a child sees a man...he calls 'a ma n.' This natural way of separating words is fundamental to teaching reading...

This reasoning is essentially based upon a subject matter analysis. Stern has analyzed spoken words and concluded that they are usually broken into consonant-vowel units such as ma n, fa n, rather than vowel-consonant units such as m an and f an. The assumption that spoken patterns facilitate the acquisition of blending leads to the following conclusion: printed images in beginning reading should be broken into the same units as their spoken counterparts. Since the printed image ma n accords with the way in which these images are naturally spoken ("ma n"), according to Stern, then the child's insightful response of "man" to the image ma n will be facilitated by their natural sound-symbol correspondence.

The question "which perceptual set...?" may be less important than the fact that more than one should be taught. Teaching several different sets in a programed sequence should help the child to generalize his perception. Purposely shifting the perceptual set from first one, last two to first two last one or the reverse would contribute to a more abstract level of skill mastery in the perceptual dimension.

We chose Stern's framework because in a sense we were obligated to coordinate our program with the school's use of Stern. The children in our kindergarten sample would go on to Stern in first grade. Not knowing the effect of teaching both sets and not having sufficient project time to study the effect, we chose not to raise the problem at this time.

Once a child had analyzed a 3-letter word, using his knowledge of the letter sounds in conjunction with the perceptual set, into two units (pa, t), he then faced the task of synthesizing (mixing or blending) these two units together to say the whole-word sound (pat). A correct analysis of a three-letter word such as pom required the child to orally produce two separate sounds: "po, m" in that order. A correct synthesis required the child to orally produce the sound "pom," which represented the blended sound of the two units.

In the transfer test the children were presented with seven new trigrams: mos, pom, sap, pas, mat, sos, sot. These trigrams were composed of familiar letters and bigram combinations taught in the program but were unfamiliar (not taught in the program) in their whole word (trigram) structure. Each word was presented individually to one child at a time.

Tester:	shows child the word sap "Say the sound of the first two letters."
Child:	says "sa"
Tester:	records response "now say the sound of the last letter"
Child:	says "p"
Tester:	records response "now say the sound of the whole word."
Child:	says "sap"
Tester:	records response, shows next word and repeats above routine.

The transfer test required each child to produce three distinct sounds for each of seven trigrams: two analytical sounds (first two letters, last letter), and one synthesis (whole word). These three sounds were considered as one response chain for each trigram. The response chains were analyzed for 33 first grade children and 15 kindergarten children. The 33 first graders could produce a maximum of 231 analytical and synthesizing response chains (7 x 33), while the 15 kindergarten children could produce 105 response chains (7 x 15).

All responses fell into six categories (A to F). In four categories (A to D) the analysis was correct, buth the synthesis varied from correct, to incorrect, to incomplete, and finally to none at all. In category E both analysis and synthesis were incorrect. Category F was characterized by no response at all.

For a response to fall into Category A, all three sounds in the response chain must be correct. Responses were assigned to category B if the first two analytical sounds were correct, but the last sound, the synthesis, was incorrect in any way.

Example of Category
B Response

Sample stimulus shown to child	Sample response actually recorded	
-pom-	"po, m" ↑ Analysis correct	"pot" ↑ Synthesis incorrect (last letter substituted)

The framework used in analyzing the response chains is outlined with samples in Table 5.

Tables 6 and 7 show the distribution of responses in each category for both samples. The distributions are almost identical for both kindergarten and first grade. While only about 30% of the first grade responses and about 30% of the kindergarten responses revealed correct synthesis (category A), more than 90% of the responses for each sample yield evidence of correct analysis, (category A to D).

In terms of number of children, nearly 90% of the children in each population are accounted for in the response distributions for categories A and B. Table 8 shows that eleven (nearly 75%) of the children in the experimental kindergarten are represented in category A and thirteen (80%) are

Table 5

Definitions of Response Categories for Student Responses to First Transfer Test

A. Analysis correct, synthesis correct:

Sample Vis. Stim.	Sample response
mos	"mo," "s," "mos"

B. Analysis correct, synthesis incorrect:

Sample Vis. Stim	Sample response
pom	"po," "m," "pot"
sap	"sa," "p," "pat"

C. Analysis correct, synthesis incomplete:

Sample Vis. Stim.	Sample response
mat	"ma," "t," "ma"

D. Analysis correct, no synthesis:

Sample Vis. Stim.	Sample response
sos	"so," "s"

E. Analysis incorrect, synthesis incorrect:

Sample Vis. Stim.	Sample response
pas	"pat," "s," "pat"
sos	"sa," "s," "sam"
sap	"pa," "sa," "pa"

F. No analysis, no synthesis:

Sample Vis. Stim.	Sample response
sot	no response within 10 seconds and after probing

Table 6

Percentage and Number of Correct Responses by
Phonic Analysis and Synthesis. First Transfer Test
First Grade (total = 231 responses, n = 33)

Analysis Correct: 95.5% (221 responses)				Analysis Incorrect	No Analysis
Synthesis Correct A	Synthesis Incorrect B	Synthesis Incomplete C	No Synthesis D	Synthesis Incorrect E	No Synthesis F
29.4% (68)	41.5% (96)	9.5% (22)	15.1% (35)	3% (7)	1.3% (3)

Table 7

Percentage and Number of Correct Responses by
Phonic Analysis and Synthesis. First Transfer Test
Kindergarten (Total = 105 responses, n = 15)

Analysis Correct: 91.2% (96 responses)				Analysis Incorrect	No Analysis
Synthesis Correct A	Synthesis Incorrect B	Synthesis Incomplete C	No Synthesis D	Synthesis Incorrect E	No Synthesis F
30.4% (32)	40% (42)	6.6% (7)	14.2% (15)	8.5% (9)	0% (0)

Table 8

Number of Responses by Category and Student

First Transfer Test

Experimental Kindergarten

	Response Category (A-F)									
Student Number	A	B1.1	B1.2	B1.3	B2	B3	C	D	E	F
1	1	3			1	1	1			
2	1	4			2					
3		4			2				1	
4	2	3			1	1				
5		1					2	1	3	
6	3	3					1			
7								7		
8	1	2			2	1	1			
9	5	2								
10	5	2								
11	6						1			
12	4	1						2		
13					1		1	5		
14	2	1			3				1	
15	2	1							4	

represented in category B. The responses of the first grade children are distributed in similar proportions.

Most of the abstract blending responses in which the analysis was correct but the synthesis was other than correct fell into category B. Since the largest proportion of non-correct blends are represented in this one category, a further analysis was made of all _B_ category responses. Table 9 shows the framework used in the analysis.

All _B_ responses fell into three main sub-categories (B1, B2, B3), depending upon whether or not there was some degree of correctness or relevance to the order of the sounds produced by the child in his final blend. A child who, after correctly analyzing the word _pom_ as _po_, _m_, then said "pop" as his final blend could be said to be more correct in his choice of blends than a child who produced the blend "mom" in response to the word image _sot_. The sound "pop" has a great deal of relevance as a blend of the sounds represented in the visual image _pom_. The first two letters "po" were blended together correctly. Only the last letter _m_ was not correctly incorporated into the final blend. If a child produced the sound "pat" as a blend of the word image _pas_, this again indicated a fairly high degree of relevance. Only the last letter was not blended correctly. Such blends, although incorrectly synthesized, were observed to be at least correctly _ordered_, in the sense that some of the sounds in the final blend were in their correct position. Tables 10 and 11 show the distribution of _B_ responses for both populations (kindergarten and first grade) over all categories.

Again, the first grade figures are almost identical to the kindergarten figures. Two categories account for nearly all responses: categories B1.1 and B2. In B1.1, all responses were correctly ordered since only the last letter in the word image was incorrectly blended. This category, it should be

Table 9

Definitions of Sub-Categories for
Student Responses in Category B,
First Transfer Test

B. Analysis correct, synthesis incorrect:

1. Synthesis incorrect, order of final blend correct.

Sample Stim.	Sample response
pom	"po," "m," "pop"
pas	"pa," "s," "pot"
sot	"so," "t," "sat"

1.1 Order of final blend correct, last letter substituted.

Sample Stim.	Sample response
pas	"pa," "s," "pat"

1.2 Order of final blend correct, middle letter substituted.

Sample Stim.	Sample response
sot	"so," "t," "sat"

1.3 Order of final blend correct, last two letters substituted.

Sample Stim.	Sample response
pas	"pa," "s," "pot"

2. Synthesis incorrect, order of final blend incorrect. (reverse synthesis)

Sample Stim.	Sample response
pom	"po," "m," "mop"
pas	"pa," "s," "sa"
sap	"sa," "p," "pat"
pom	"po," "m," "mom"
mos	"mo," "s," "sam"
pas	"pa," "s," "sat"

3. Synthesis incorrect, final blend irrelevant.

Sample Stim.	Sample response
sot	"so," "t," "mom"

Table 10

Percentage and Number of Incorrect Blends, Correctly Ordered. First Transfer Test, Kindergarten (Total = 42 responses, n = 13)

B Analysis Correct Synthesis Incorrect 40% (42)				
B1 Blended Order Correct 64.2% (27)			B2 Blended Order Incorrect (Reverse Synthesis)	B3 Final Blend Irrelevant
Last Letter substituted B1.1	Middle letter substituted B1.2	Last two letters substituted B1.3		
64.2% (27)	0% (0)	0% (0)	28.5% (12)	7.1% (3)

Table 11

Percentage and Number of Incorrect Blends, Correctly Ordered. First Transfer Test, First Grade (Total = 96 responses, n = 26)

B Analysis Correct Synthesis Incorrect 41.5% (96)				
B1 Blended Order Correct 66.5% (64)			B2 Blended Order Incorrect (Reverse synthesis)	B3 Final Blend irrelevant
Last letter substituted B1.1	Middle letter substituted B1.2	Last two letters substituted B1.3		
64.5% (62)	1% (1)	1% (1)	25% (24)	8.3% (8)

recalled, accounted for about 40% of the noncorrect blends from each sample. Of this 40% nearly 65% yielded evidence of correctness in the order of the first two letters of the child's final blend.

Category B2 responses account for most of the remaining incorrect blends This category is distinguished by the fact that the final blends show a tendency to reflect the reverse of the word image. A good example is the response of "mop" to the image pom.

E. Discussion.

At first the overall reaction of the Ss to the abstract transfer test seems one of weak transfer in the blending dimension. Yet a closer analysis of the responses reveals a very high degree of mastery in the analytical dimension. This same analytical strength can be seen in a closer observation of the final blends. Here, as much as was possible, the children tended to at least maintain correctness in order of the letters in the final blend. The lesser tendency, reflected in category B2 responses, to produce the reverse of the word image as the final blend, is essentially a tension on the part of the child between producing a known word image as the final blend and permitting the order of the letters to dominate the child's choice of sounds. In most response cases (80%) the children did permit the order of the letters, represented in the word image, to dominate their choice of sounds in the final blend. In terms of number of children, Table 8 shows that twelve (about 80%) of the experimental kindergarten children are represented in the more desirable category of category B1.1, while less than 50% are represented in the reversal category B2. The first grade children distributed their responses in similar proportions.

References

Bloomfield, L. and Barnhart, C.L. Let's read; a linguistic approach. Detroit: Wayne State University Press, 1961.

Silberman, H. F. The development of a beginning reading program. Santa Monica, Calif.: Systems Development Corporation, 1964.

Stern, C. and Gould, T.S. Children discover reading; an introduction to structural reading. Syracuse: Random House-Singer, 1965.

Chapter VI. Transfer Study: The Facilitation of the Acquisition of Phonic Elements through the Application of Learned Behavioral Structures

The results reported in Chapter V of this report show that the children learned the phonic elements and their blended combinations (the six single letters, six bigrams and seven trigrams) from the lesson sequence. In addition to the specific phonic elements and blends, the children also learned to perform within the behavioral structures in which these elements are presented. Chapter IV discusses the behavioral structure as "a rule which defines the way in which words and pictures are arranged in order to teach a wide variety of content." So, in learning the phonic elements and blends, the children learned the rules of the game. That is, they learned to respond differentially to a variety of complex audio-visual stimuli. For example, the children learned to produce a variety of behaviors in the presence of each trigram (e.g., saying the word, its phonic elements, or combinations of these), according to the instruction paired with the trigram. Detailed examples of these behaviors are presented in Table 1. The lesson sequence employed a total of thirty-three different behavioral structures which are presented in Appendix D.

The fact that the children learned to operate within these behavioral structures indicates the hypothesis that this performance will tranfer to tasks involving the learning of new phonic elements and blends. That is, after a child has completed the lesson sequence, his acquisition of new phonic material should be facilitated by the use of the familiar behavioral structures.

Table 1

Examples of the Trigram Behaviors

Visual Stimulus	Auditory Stimulus	Response
mom	"Say the sound of the first two letters."	mo
mom	"Say the sound of the last letter."	m
mom	"Say the sound of the first two and the last."	mo, m
mom	"Say the sounds; then say the word."	mo, m, mom
mom	"Just say the word."	mom

To test this hypothesis two new lesson sequences were designed. Each sequence was to teach two new phonic sounds and comparable sets of new blends (six bigrams and seven trigrams) within the familiar behavioral structures. For the purposes of this chapter the original lesson sequence will be called Cycle 1, and the two new cycles will be called Cycle 11 and Cycle 111. (See Tables 2 and 3).

A. The Design of Cycle 11 and Cycle 111

The design for both Cycles 11 and 111 was abstracted from the Cycle 1 sequence. To derive the most simple or parsimonious sequence format from Cycle 1, the behaviors in Cycle 1 were divided into three descriptive categories: (1) supportive behaviors, (2) perceptual behaviors and (3) basic phonic behaviors. The behaviors included in each of these categories are shown in Table 3. The supportive behaviors were useful in the initial acquisition for gradually building the basic phonic behaviors, but they did not need to be repeated in the training of new phonic elements. Therefore, the supportive behaviors were not included in the design of Cycles 11 and 111. The perceptual behaviors were generalized and, once trained, could be applied to any material containing know phonic elements. Thus it was not necessary to include perceptual learning trials in the design of Cycles 11 and 111. Therefore, the category of the basic phonic behaviors included all of the behavioral structures necessary for the learning of new phonic elements and blends. The design of Cycles 11 and 111 included only these basic phonic behaviors.

The new cycles were designed in the tutorial book form (described in Chapter IV) for two reasons. First, the tutorial book form allows rapid lesson development, whereas the machine requires time in planning, writing,

Table 2

New Phonic Elements and Blends Presented in the Three Lesson Sequences

	Cycle I	Cycle II	Cycle III
Single sounds	m, o, p, s, a, t	n, i	f, e
Bigrams	mo, so, po, ma sa, pa	mi, si, pi na, no, ni	me, se, pe fa, fi, ta
Trigrams	mom, pop, mop sam, sat, pat pot	pit, mit, sit nip, nap, not man	met, pet, set fat, mat, ment, tap

Table 3

Examples of the Three Categories of Behaviors Taught in Cycle I

Supportive Behaviors	Perceptual Behaviors	Basic Phonic Behaviors
Single Sound Indicating	Letter Order (first, last)	Single Sound Oral Construction
Unitary Indicating	Perceptual Set (initial bigram and final consonant	Bigram Blending
Unitary Oral construction		Trigram Blending

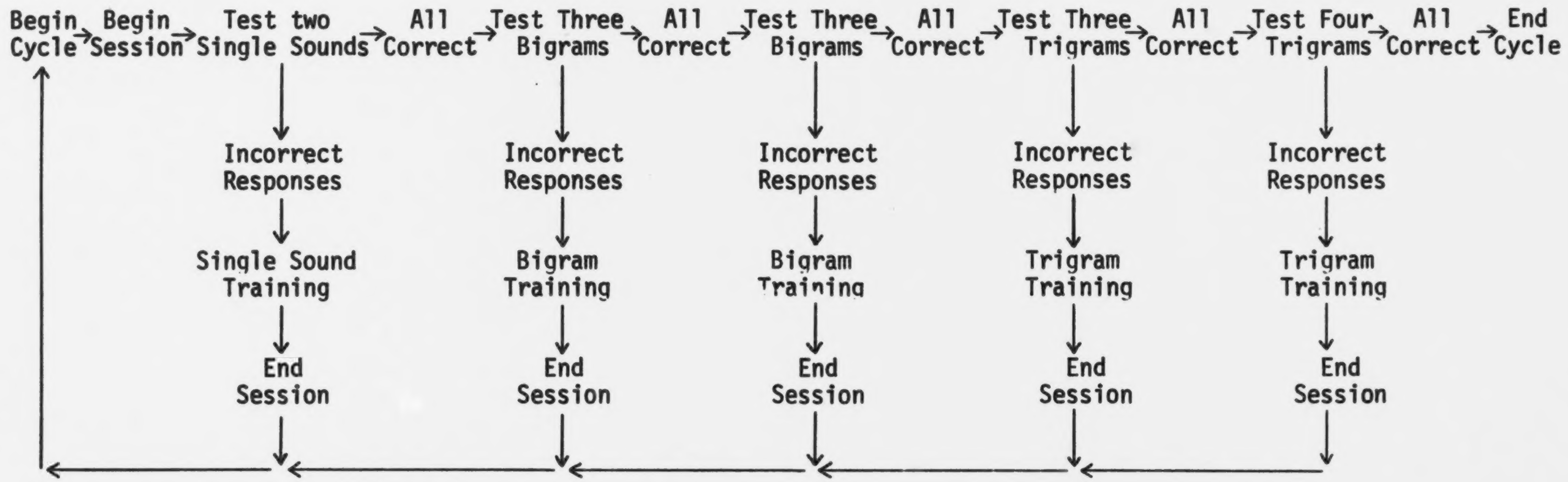
and in the preparation of materials. Also, the tutorial book form allows a flexibility in internal branching not afforded by the linear function of the machine. Internal brancing implies the ability to alter the lesson on the basis of the child's response. This technique was necessary to make accurate determinations of the minimum number of trials necessary for learning the new phonic elements.

The phonic elements to be presented in the new cycles were divided into five sets: the two single letters, two sets of three bigrams each, a set of three and a set of four trigrams. Figure 1 illustrates these divisions and the internal branching used in the design of these new cycles. In a given session a child was first tested on the two single sounds. If he made one or more incorrect responses he entered the training modules in single sounds and, when the training was completed, the session was terminated. Once a child entered a training module, internal branching procedures were used to vary the number of trials until the child had established a specified rate of correct responding. If the child made the correct responses in the single sounds test he was immediately tested on the first set of three bigrams. Incorrect responses led to the training module on these bigrams, and so on. In this way the child could demonstrate mastery of the two new phonic elements and blends by progressing through all five units of the criterion test without errors, thus ending the cycle.

B. Subjects

Ten children were selected from the subjects who completed Cycle I (see Chapter V) to receive the Cycle II treatment. These were Ss 1, 2, 3, 6, 7, 8, 9, 10, 11, and 15--the first ten Ss to complete Cycle I. Due to the time limits of the project, Cycle II could not be administered to any child who had not finished Cycle I by April, 1968. The first four Ss who

Fig. 1 Illustration of the five divisions and internal branching techniques used in the design of Cycles II and III.


Begin Cycle
Begin Session
Test two Single Sounds
All Correct
Test Three Bigrams
All Correct
Test Three Bigrams
All Correct
Test Three Trigrams
All Correct
Test Four Trigrams
All Correct
End Cycle
Incorrect Responses
Single Sound Training
End Session
Incorrect Responses
Bigram Training
End Session
Incorrect Responses
Bigram Training
End Session
Incorrect Responses
Trigram Training
End Session
Incorrect Responses
Trigram Training
End Session

completed Cycle 11 (Ss 7, 9, 10, and 11) were immediately started on Cycle 111. Time limitations prevented including more Ss in this section of the study.

This selection criterion, then, reflects two different factors: when the S began Cycle 1; and the speed of acquisition in Cycle 11. Of the Ss who began Cycle 1 early in the school year, most were finished in time to receive Cycle 11. Of the Ss who began the Cycle 1 sequence during and after December of 1967, only those who moved quickly through the sequence were finished in time to receive Cycle 11.

C. Procedures

Each S was run daily when attendance and school schedule permitted. The S was brought to the experimental setting and was seated in one of the machine booths. The tutor was seated next to the S and the tutorial book was placed on a table before them. A timer was started as soon as the book was opened. The experimenter watched through a one-way vision screen and recorded on a data sheet all of the responses made by S in a given session. This procedure gave detailed data on the time, the number of sessions, and the number of trials required by each S to master all of the phonic elements contained in each of the divisions of the Cycle 11 and 111 design.

D. Calibration of the Cycle 1 Results

Whereas Cycle 11 was designed specifically to give minimum acquisition data on sessions, trials, and time, Cycle 1 was constructed on the basis of developmental data to emphasize positive acquisition results. Only secondary attention was given to such detailed data as the latter. Consequently, certain manipulations had to be performed on the Cycle 1 data to render it comparable to the Cycle 11 data.

1. Number of Sessions: Records were kept on the lessons each child

received as he progressed through the Cycle I sequence (see Chapter V). So, to determine the number of sessions each child required for the acquisition of the phonic elements and blends, the number of lessons pertinent to each set of phonic elements and blends was simply counted. For the single sounds, only the sessions including the initial three sounds (m, o, and p) were counted.

2. Time: In the absence of other time data, the minimum time required to process each machine lesson was obtained. It was determined that the Cycle I tutoring sessions required a minimum of 7 minutes, so this was used as the estimated time for all tutoring sessions.

3. Number of Trials: For the machine lessons and the trigrams lessons, the number of trials was predetermined. In the case of the single sound sessions (lessons 3-14) involving three letters, two-thirds of the trials were considered, since Cycles II and III involved only two letters. For sessions dealing with bigram acquisition, however, the number of trials per session varied. It was estimated that these sessions contained at least six trials for each phonic element, and this estimate was used in determinations of the number of trials for these sessions.

Of the three categories of behaviors trained in Cycle I (Table 3), only the basic phonic behaviors were clearly pertinent to the comparison of Cycle I results with Cycle II and III results. Therefore, all of the data on supportive behaviors and perceptual behaviors were omitted.

E. Results

1. The 10 Ss who received Cycle II: The total number of trials required for the individual Ss to reach criterion are shown in Figure 2. Figure 2A shows the dramatic reduction in the number of trials required by

Figure 2. Number of trials required by each Student to reach criterion performance on 2 single sounds, 6 bigrams and 7 trigrams.

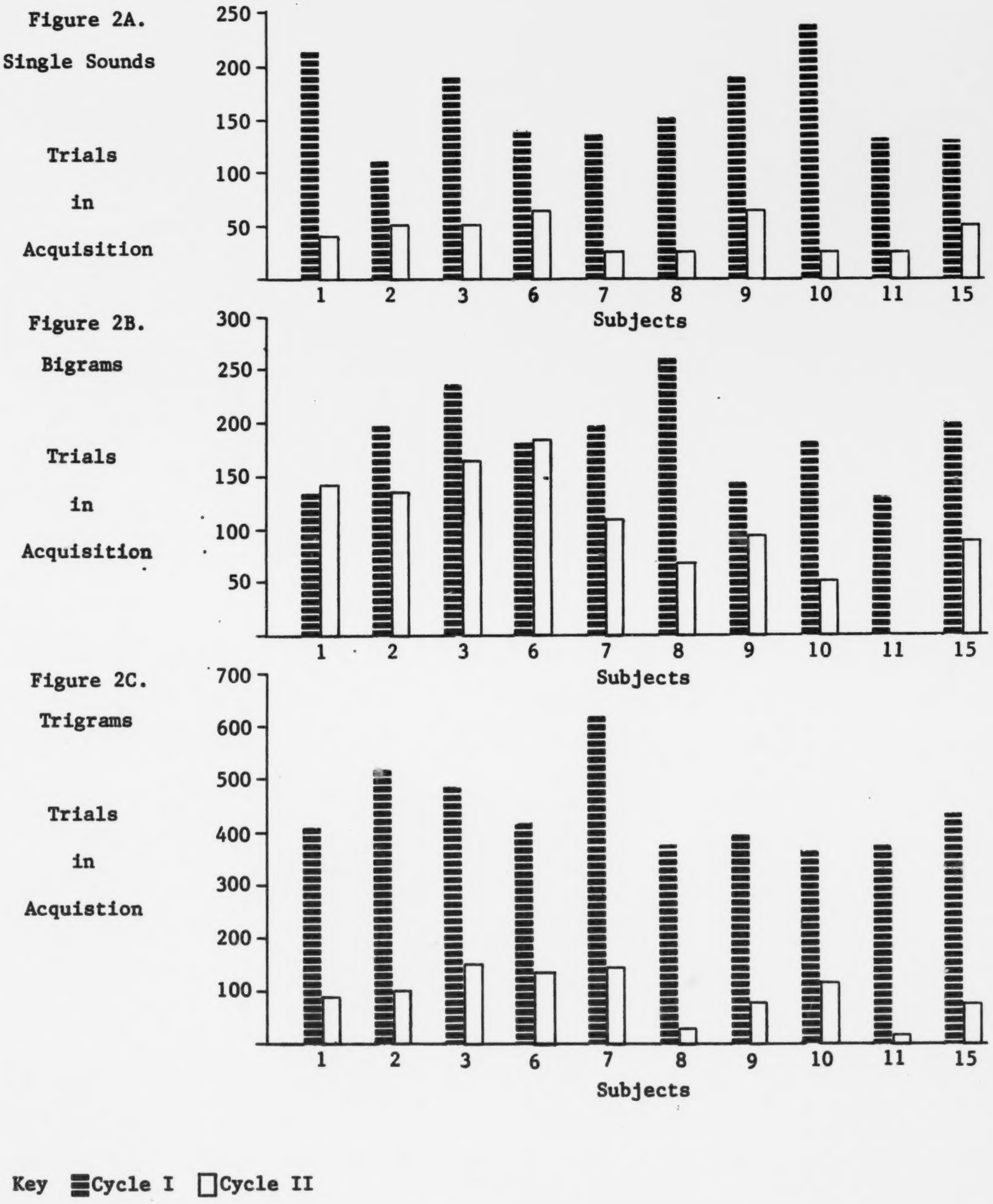


Figure 2A. Single Sounds

Figure 2B. Bigrams

Figure 2C. Trigrams

each *S* to reach single-sound criterion in Cycle 11 (as opposed to their performance in Cycle 1). This difference was obtained for every *S*, and ranged from a reduction of 214 trials for *S* #10 to a reduction of 57 trials for *S* #2. The results are not as dramatic for the acquisition of bigrams, shown in Figure 2B, since two of the ten *Ss* required a few more trials in Cycle 11 than in Cycle 1. The Cycle 1-Cycle 11 differences in the bigram sections ranged from a decrease of 188 trials for *S* #8 to an increase of 20 trials for *S* #1. The dramatic reduction in the number of trials appears again, however, in the trigrams sections shown in Figure 2C. Here the differences ranged from 476 fewer trigram trials in Cycle 11 for *S* #7 to 259 fewer for *S* #10.

The data gathered for sessions and time to reach criterion are summarized as medians in Figures 3 and 4. As one would expect from the previously presented trial data, the results show a clearcut reduction in the number of sessions and time required to reach criterion in Cycle 11 in contrast with Cycle 1. The deviations from the expected trend in the bigrams which we noted are averaged out and no longer appear.

2. *The 4 Ss who received Cycle 111*: Figure 5 shows the number of trials required by each of the four *Ss* to reach criterion on each of the three cycles. Figure 5A shows the large reduction in the number of trials to reach criterion from Cycle 1 to Cycle 11 for the single sounds, and a further reduction on the number of trials from Cycle 11 to Cycle 111. The values obtained from Cycle 111 are near zero, ranging from zero to 13 trials. A score of zero trials to criterion indicates that once the letter sound was presented, the *S* never failed to produce the correct sound in the presence of that letter. In the bigrams sections, shown in Figure 5B, all four *Ss* required fewer trials in Cycle 11 than Cycle 1,

Figure 3. Median number of sessions required by 10 Students to reach criterion in Cycle I and Cycle II.

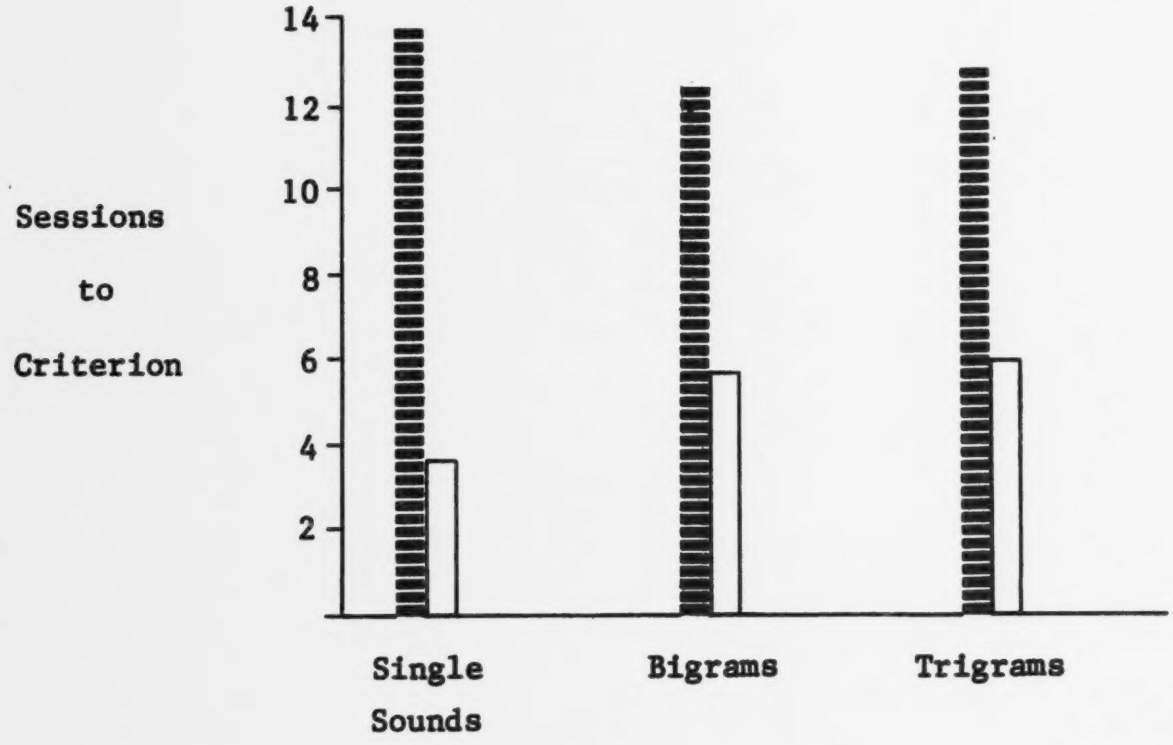
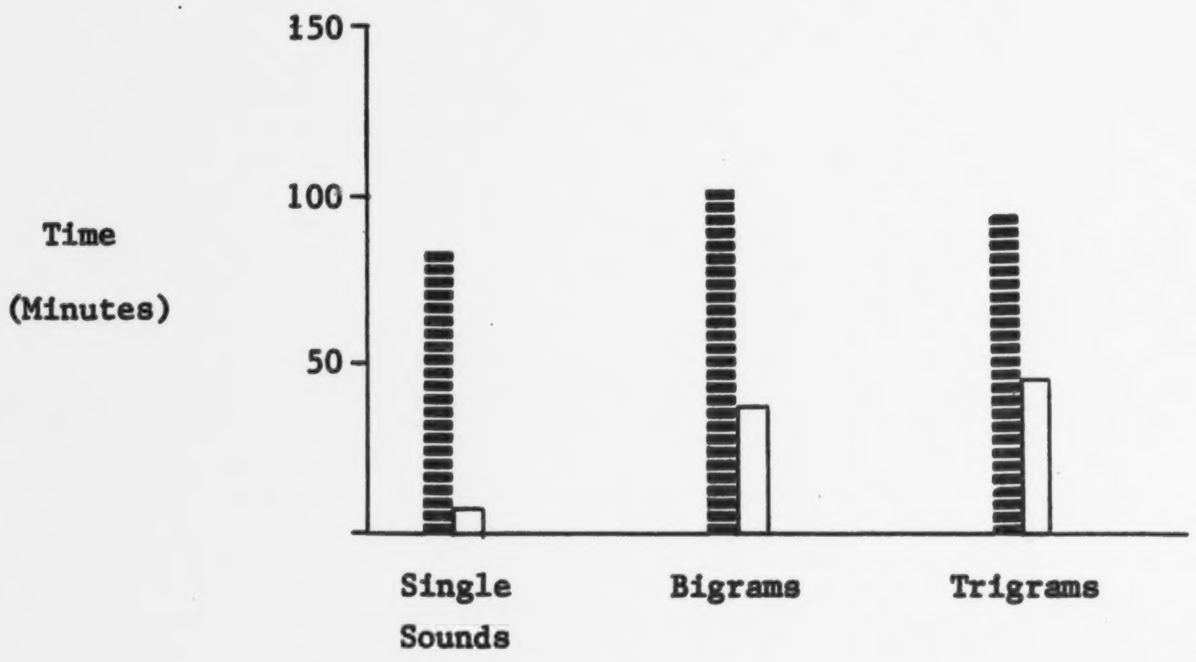


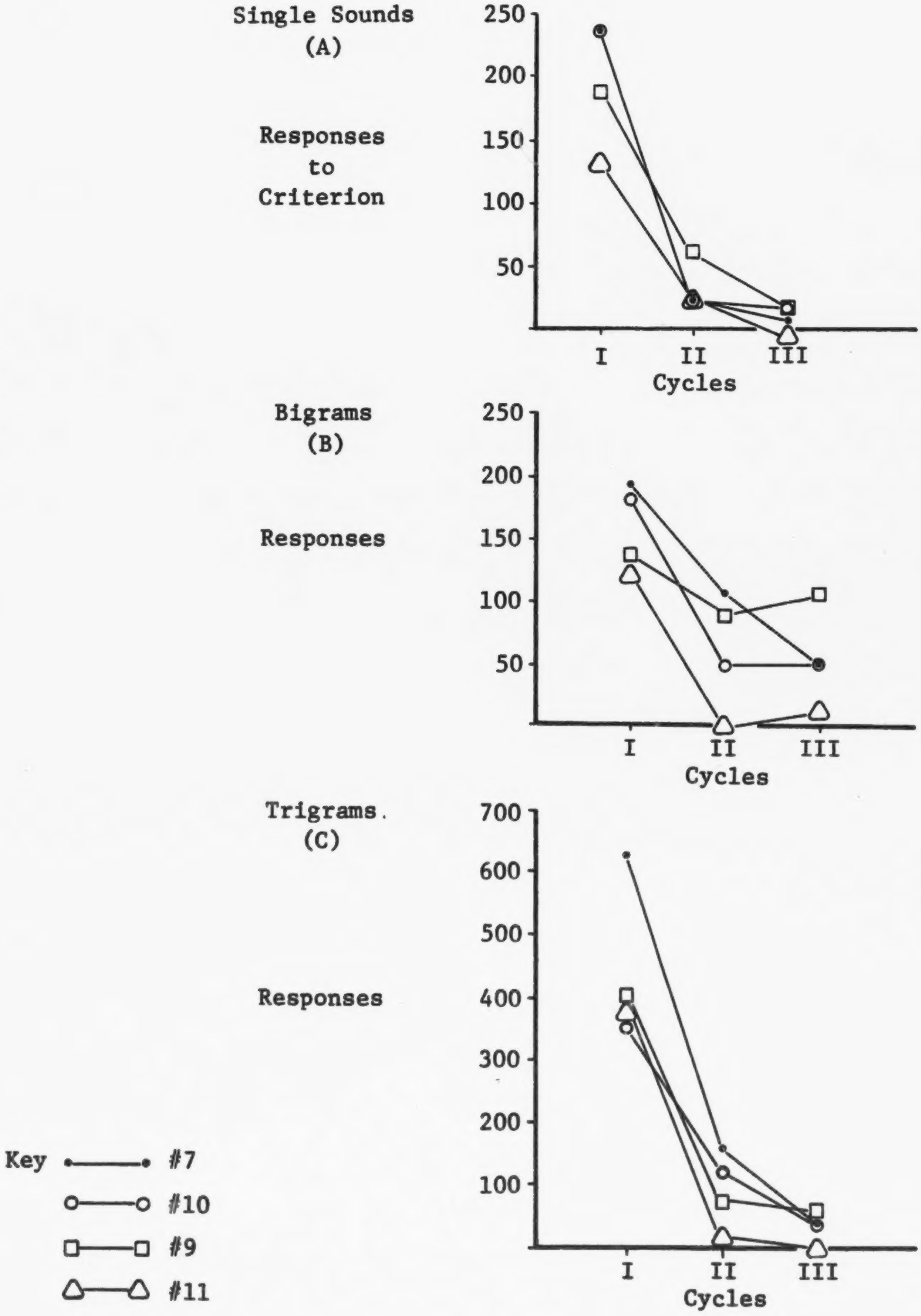
Figure 4. Median time required for 10 Students to reach criterion in Cycle I and Cycle II.



Key ▤Cycle I ☐Cycle II

Figure 5.

Responses to Criterion as a Function of Cycle for Single Sounds (A), Bigrams (B), and Trigrams (C) of the 4 Ss who Received Cycle III Treatment.



indicating that none of these Ss contributed to the deviations previously noted in this comparison. However, two Ss required more trials to master the Cycle 111 bigrams than the Cycle 11 bigrams, one required the same number of trials, and only one S demonstrated the expected decrease in the number of trials to criterion. The expected reduction in number of trials reappears in the trigrams sections shown in Figure 5C. Here the large Cycle 1-Cycle 11 reduction is obvious, and the trend continues with all Ss showing a further reduction in the number of trials required to reach criterion in Cycle 111. A zero score in the trigram section (see S #11, Cycle 111) as well as in the bigram section (see S #11, Cycle 11) indicates that the S, knowing the component sounds, was able to look at the novel combination of letters and produce their blended sound without help.

The number of sessions and time data are summarized as medians in Figures 6 and 7. The expected reductions are readily apparent for the single sounds and trigrams in both figures. That is, each successive cycle produces a reduction in the number of sessions and time required by the group to acquire new sets of single sounds and trigrams. In the case of the bigrams there is a clear reduction in the number of trials and time from Cycle 1 to Cycle 11, but this is not evident in the comparison of Cycle 11 and Cycle 111. Although there is a slight reduction in the number of sessions required in Cycle 111 as opposed to Cycle 11, there is an increase in the time required to master the Cycle 111 bigrams. This is a reflection of the previously noted deviations from the expected decrease in the number of trials to master the Cycle 111 bigrams. Whereas the Ss required on the average fewer sessions to master the Cycle 111 bigrams, their failure to quickly attain a criterion level of responding in the

Figure 6. Median number of sessions required by 4 Students to reach criterion in Cycles I, II and III.

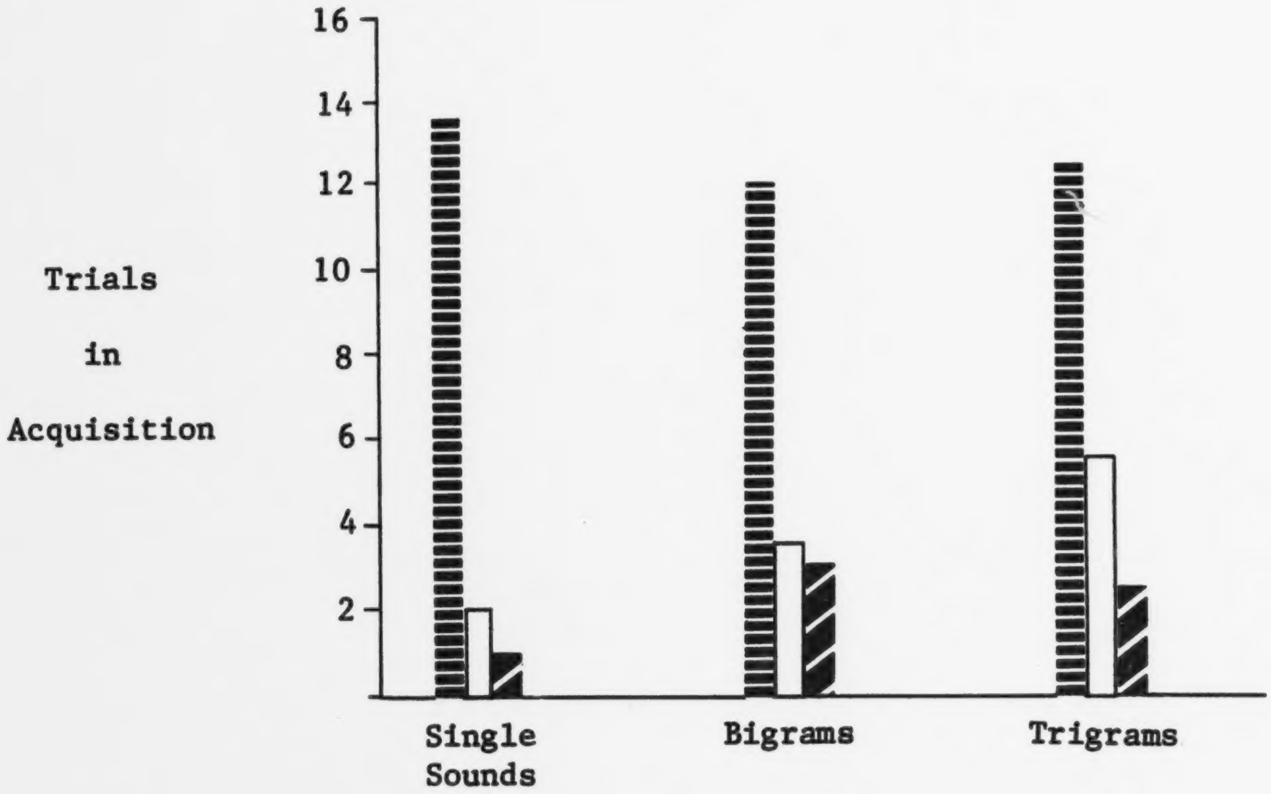
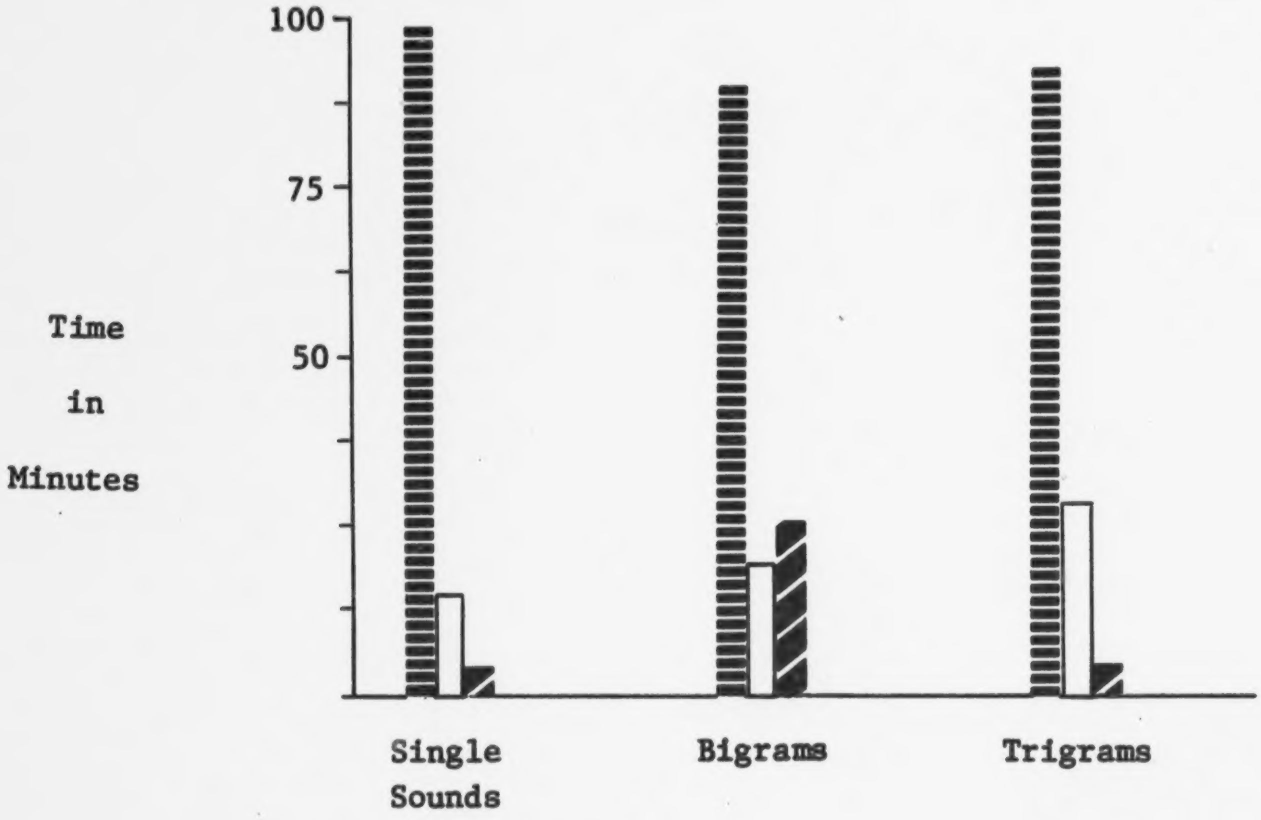


Figure 7. *Median time required by 4 Students to reach criterion in Cycles I, II and III.*



Key ▤Cycle I ☐Cycle II ▨Cycle III

training modules resulted in an increase in the number of trials and amount of time required to master these bigrams.

F. Discussion

The results of this experiment clearly lend support to the hypothesis that the acquisition of the new phonic elements and blends was facilitated by previous phonic learning within defined behavioral structures. That is, the acquisition of the Cycle 11 materials was facilitated by Cycle 1, and the acquisition of the Cycle 111 materials was facilitated by Cycle 11. The hypothesis of transfer to new phonic elements, however, represents a limited statement of the transfer produced by previous learning.

The complex audiovisual stimuli included in these behavioral structures may be varied in many ways: through the form of the auditory instruction (e.g. varying the question which leads to the response), through the size, shape, and color of the visual stimulus, through the context of the visual stimulus (book, slide screen, blackboard, tv, etc.), and through various other manipulations. In this regard it is important to note that the behavioral structures defined in this study were of a particular nature in that they were logically abstracted from a set of empirically derived structures. Whether another set of structures, lacking empirical foundation, would have worked equally well is questionable. A more interesting issue is how these structures may be modified to yield a more efficient learning process, an approach suggesting a stronger empirical foundation for the definition of the structures.

A further implication of the present study is that transfer probably occurs over a wide range of learning outside the limits of phonic materials. Since the behavior involves the learning of abstract sound-symbol connections, it is reasonable to suppose that what holds for these phonic materials will also hold for other abstract sound-symbol tasks such as letter names, numeral names, and color names. Furthermore, this transfer may even extend to the concrete sound-symbol learning task involved in the acquisition of some language and sight word reading skills. The notion that the improved acquisition of phonic sound-symbol connections may have generalized to other sound-symbol tasks is a promising and important avenue of investigation.

It has already been noted in the results section that a score of zero trials in the single sound learning indicates that a child made only correct responses once the sound was introduced. This statement also holds for the introduction of two sounds inasmuch as the sequence construction involved the introduction of two new sounds in each new cycle. In other words, the child (See Figure 5A, S #11 in Cycle 111) who scored zero trials learned two new phonic sounds in a single session without any errors. No child in Cycle 111 required more than a single session to master the two new sounds, although one or two errors were made in the acquisition of these sounds. The implication here is that once the children have thoroughly mastered several phonic sounds their capacity to learn new sounds is greatly accelerated. This leads to the conclusion that, rather than teaching a large number of phonic sounds (more than 10) at once, a better procedure would be to teach a few sounds to a high level of mastery, increasing the rate of introduction as the child's capacity to learn new sounds is increased.

A zero score on trials to criterion for bigram blending and trigram blending (see Fig. 5B, S #11, Cycle 11 and Fig. 5C, S #11, Cycle 111) indicates that the child was able to look at the two- or three-letter configuration and, knowing the individual letter sounds, produce the blended sound of the configuration. Once a child has mastered the blending skill at this zero-trial level he is capable of reading all the regular trigrams which are composed of familiar phonic elements. Although only one S attained this level of mastery, there is reason to believe that the other three Ss who received Cycle III would eventually reach this same level with repeated practice. This is at least true of the trigrams learning (see Fig. 5C), in that all Ss improved with each new cycle indicating that they would eventually attain a level of zero-trials to mastery in further cycling with new materials.

There is less evidence in the data for the prediction that repeated practice would lead to a zero-trials level of mastery for the bigram blending skill (see Fig. 5B) where the performance of only one subject improved from Cycle II to Cycle III. This deviation from continued improvement was due to a particular phenomenon which can only be described as it was observed, since no relevant data were collected on this problem. It was observed that, although [illegible] had easily mastered the new single sounds, they had difficulty in producing these sounds in blended combinations. For example, one S who had easily mastered the individual f sound would produce the blending chain "f, a, ca" in response to the bigram fa. In other cases the children would either mispronounce the vowel in the blended bigram or produce the sound of an already familiar bigram in the presence of the novel bigram. Observational evidence indicated that this was a problem in response production rather than in the acquisition of the actual phonic materials. Perhaps practice in sound matching and sound production would be a fruitful approach to the solution of this problem, but more research in this area would be necessary to draw any definite conclusions. Nevertheless, the deviations from the trend of continued improvement with each new cycle in the bigram section may be attributed to response production problems rather than to a failure to improve in the application of the blending skill. It might be supposed that, given the solution of the sound production problem, all Ss who received the Cycle III treatment would continue to improve on bigram blending until they attained a zero-trials level of mastery.

It should be noted in closing that this highly structured phonics program may offer a powerful research tool for investigations into several important areas of education. The sequence can be modified to obtain exact control over the number and nature of each trial; internal branching techniques can be added similar to those included in the Cycle II and Cycle III sequences reported here; and the sequence can be implemented on instrumentation designed to collect response latencies and other relevant data. The sequence might be used for research in the area of programed instruction to investigate the relationships between latency and error responding. Also, the program might be used to detect individual learning styles in a study of individual differences. There are many other research possibilities inherent in this type of program design.

Chapter VII. Summary, Significance, and Implications

This final chapter seeks to summarize the major data results of the study, to discuss the overall significance of the study, and to describe some practical outcomes or extensions of the present work.

A. Summary of the Data

1. In a Harlem school setting a sequence of analytically oriented beginning reading skills was empirically derived for use with five-year old children who have little or no knowledge of the reading skills being taught.

2. At the outset of the development of the series of skills, complex teaching machine technology was used. That is, all the instructional events--audio and visual--were presented by machine. The particular machine was the Edison Responsive Environments instrument.

3. The sequence of skills was administered in two different experimental settings on an individualized basis. In our own laboratory, subjects were kindergarten children whose mean measured IQ was 85. Of the 22 children whose attendance was consistent enough to complete the sequence, 16 (73%) completed the entire sequence. Of the 16 who completed the sequence, none fell below the 85% mastery level of the terminal objectives, while 10 achieved 100% mastery. Of the 6 children showing stable attendance but slow progress, 4 who received intensive branching and highly individualized treatments showed considerable progress. On the other hand, 2 (less than 10%) of the 22 did not complete the first level of producing three sounds to their corresponding letters. The mean time for completing the sequence for the 22 subjects was approximately 7 instructional hours. In another

setting 33 first graders proceeded through the same lesson sequence entirely with lessons presented by machine. Thirty-two (97%) recorded 100% mastery on the posttest reading of the words.

4. An abstract transfer test was given to see if children could apply what they had learned to letter sequences they had not been taught in the lessons. Of the 16 children who completed the lesson sequence, 15 were available to take the transfer test. Of the 15, 11 (73%) gave definite evidence of transfer to abstract blending. On the average they were able to blend 3 of 7 abstract trigrams. Results of abstract blending were similar for both the experimental kindergarten and first grade populations.

5. Additional evidence of what had been learned was obtained by comparing how efficiently and effectively children who completed the lesson sequence would acquire a similar amount of content involving new sounds. Despite some problems in sampling and in equating content, the data suggest the relevance of the strategy of teaching a skill sequence and then recycling. Evidence for this conclusion follows and lies in the fact that, for the ten children who completed Cycle 1 in time to complete Cycle 11, the median number of sessions to mastery was reduced to:

(a) 1/4 as many for single sounds
(b) less than 1/2 as many for bigram blends
(c) less than 1/2 as many for trigrams. Similar data were obtained for the comparative amounts of time to complete the cycles (Chapter VI), with the noted exception of bigram learning.

Moreover, for the four children who completed Cycle 11 in time to complete Cycle 111, the data were even more powerful. The number of sessions to mastery was reduced to:

(a) for single sounds, less than 1/6 as many for Cycle 11 and less than 1/12 as many for Cycle 111.

(b) for bigram blends, less than 1/3 as many for Cycle 11 and less than 1/4 as many for Cycle 111.

(c) for trigram blends, less than 1/2 as many for Cycle 11 and 1/4 as many for Cycle 111.

Thus, for each type of skill, mastery of Cycle 111 was completed in fewer sessions than Cycle 11. Similar data were obtained with amount of time and number of responses as criteria.

B. Significance of the Results

The significance of the study will be discussed in terms of five interrelated issues: (1) reading readiness, (2) empirical derivation of instructional sequences, (3) individualization of instruction, (4) complex instructional technology, and (5) the content strategy of teaching a structural sequence of skills.

1. Reading Readiness: A most pervasive and controversial issue generated by the results of the study revolves about the traditional concept of reading readiness. Historically, it has been the function of kindergarten programs to provide children with general reading readiness experiences. The child has been expected to gain a general orientation to books by listening to and telling stories. Sometimes the teacher transcribes children's stories and experiences to charts. Among many early childhood educators a mood of great trepidation and resistance is generated regarding direct instruction of any kind--but especially in reading. "Wait," we are warned, "until the child is ready."

We do not criticize the traditional activities which constitute early childhood educational programs. However, while we do not challenge the relevance of many of these activities for reading comprehension and for writing, we have demonstrated in this study the successful use of direct reading instruction with children generally labeled as slow learners. In our sample of children whose attendance was regular enough to permit their completing the program, only two, less than 10%, of the 22 did not show gains. That is, more than 90% indicated by their achievement that they were ready for direct reading instruction. Instead of providing general readiness experiences we began by teaching the child difficult abstract reading skills directly. The measure of the child's readiness was his ability to acquire these skills in an individualized instructional setting. If a child required more practice with a particular skill, he was given that practice. It is especially important to note that the skills which were taught were abstract skills. From a knowledge of a few sounds the child moved directly to blending skills. Furthermore, the child did not handle letters or even write them. The instructional program concentrated directly on reading. The single obvious finding is that this group of children, whose mean IQ is 85, showed by their learning that they were ready for instruction.

In all fairness to those persons who question such direct instruction, it is important to recognize the conditions under which these results were obtained. The principal interrelated conditions that led to these kinds of results were: the instructional sequence was empirically derived; instruction in both the developmental and validation phases of the project was individualized; complex instructional technology was used during the developmental phases; and that a structured sequence of reading skills was taught.

2. Empirical Derivation of Instructional Sequence: Crucial to the kinds of results obtained is the fact that the instructional sequences were empirically

derived. The process of empirical derivation was based upon individual treatment of each child, the use of machine technology, and continuous revisions of lessons based upon actual outcomes.

The instructional sequence passed through many revisions. This was possible because, intrinsic to our research project was the rare luxury that, during the two years of developmental work we were not committed to teaching one group of children continuously. This enabled us to design limited sequences of lessons and try them with a small number of children, usually fewer than 10, on an individual basis. The knowledge gained from working with that small number of children could then be used to revise or even scrap the sequence completely. For example, the first developmental sequence was only 18 lessons; the second was 16. Thus, we had the luxury of working in the real world without being committed to the full implementation of a reading program. That is, if the sequence was not satisfactory, we were not committed to continue building on it. Instead, we could begin again, using a new group of children.*

3. Individualization: Individualization was crucial in both the derivation of the sequence and in the validation studies. By observing each child individually we were able to identify when and where in a sequence individual children had difficulty. This provided the opportunity to distinguish between problems which were inherent in the lesson sequence and problems attributable to individual differences.

In working with each child individually the difficulty that each learner encountered was confronted. This permitted the identification of critical subskills, such as the coordinated looking at and saying of the sounds of two or more letters in left to right order. Significantly, we found that this particular skill should be taught before the child was taught to produce the blended sound (see Chapter III). This skill was identified by observing the long latencies of several children who gave evidence of blending but did so too slowly for the blending to be instructionally useful.

---

*Those interested in an extended account of the nature and value of this orientation to developmental testing should read Markle, Susan. Empirical testing of programs. In Lange (Ed.), The sixty-sixth yearbook of the National Society for the Study of Education, Chicago, Illinois: 1967.

An interesting issue arose in the implementation of individualized progress. The senior author maintained that when a child was absent, not only should the child start where he left off but that he should receive a refresher lesson. It was felt that if the child missed three or four days of school, he should not be expected to start where he left off. This issue is especially relevant to the education of children in ghetto schools, where absentee rates are high. Usually, when children are instructed in groups in an ordered curriculum the child who has been absent rejoins his group at whatever level the group has progressed to. In our project, this was not the case since the child could be picked up where he left off in the lesson sequence. Nevertheless it was argued that, when away from the lesson content for an extended period, the child should have the opportunity to review to ensure a pre-absentee level of mastery. However, the need for such review proved unnecessary. That is, the children did not lose their pre-absence level of skill when they were away from instruction for an extended period of time.

4. Complex Instructional Technology: Our use of complex instructional technology will be discussed in terms of (a) the contribution of such technology to research and development in learning and (b) the characteristics of the specific instrument used in this study. We wish to make it

clear that we are not discussing the contribution of machine technology to the problems of education generally; rather we are discussing its contribution to the research and development of learning sequences. Those interested in an extended analysis and discussion of relevant larger issues should read Oettenger & Marks (1968).

(a) Use of complex technology for research and development in learning

During our study we conducted a demonstration seminar each week for persons interested in our work. One of the most common questions asked during the seminar was:

> If your aim is to study the skill-acquisition process, why don't you teach these skills directly to the children yourself and observe what happens as you teach, instead of using fancy instruments like the ERE?
>
> We answered this question as follows:
>
> There are three major reasons for using an instrument such as the ERE: (a) the reproducibility of lessons, (b) the increased accuracy in the observation of learning, and (c) the discipline of programing.
>
> So far as the reproducibility of lessons is concerned, lessons can be tested with different children and we know they are the same lessons. We have, in the lessons, arranged for all the events that do the teaching. When a lesson is successful, we know that the reasons for success are contained within the lesson itself, and are not the result of extraneous factors which are often present in situations where children interact with adults.
>
> The result is that our knowledge of the skill-acquisition process is as free as possible of the effects of human variations, thus assuring us that we, indeed, have identified the underlying process and not just one particular teacher's version of that process. If we let individual teachers do the skill teaching, for research purposes we really couldn't separate the teacher's performance from the process she used. Consequently, we wouldn't know where to accurately pinpoint lesson success or failure.
>
> Furthermore, the lessons provide a permanent record of the events which do or do not make for adequate learning. When successful lessons have been constructed, it is possible to communicate to others exactly what does the teaching. Reproducibility is important because we can study lessons during the developmental stages, and the resultant lessons can be passed on to others.

Closely related to the reproducibility of lessons is the second reason: the increased accuracy with which we can observe the learning process. Accuracy is lost when we have to both teach and observe simultaneously. Having a device which can carry out direct instruction enables us to assume highly observant and objective attitudes. This is crucial to our task.

The last reason, that of the discipline required to program lessons successfully, is one whose importance we have recognized more and more. Many teachers-turned-programers have commented on the difficulties and eventually on the insights and clarifications which result from actually writing out sequences to teach subject matter which, on a more or less intuitive basis, they have been "teaching successfully" for years. This experience is intensified when lessons constructed involve the exact specifications of all audio and visual events as well as provision for critical responses without which the machine will not proceed. The experience is further intensified by working with preliterate children whose mean measured IQ is 85.

In our project the process begins with specifying the objective of the lesson. Once the initial program has been written, everyone can raise questions as to the relevance, conciseness, and assumptions of the lessons.

Not only must lessons get by the "murderers' row" of critics Caudle, Gotkin, McSweeney, Richardson, and Stuchin, but must pass the higher court of the children.*

(b) Characteristics of the ERE Instrument

What the ERE instrument can do has been described earlier in this report (Chapter II). These characteristics permit the programer considerable flexibility in producing instructional sequences appropriate for very young children (see Chapter IV). Its capabilities permit the kinds of reproducible events critical for the objectives of this project, and at a time when no other reliable equipment was available.

A special characteristic of the instrument important for a research and development project such as ours is the ease of encoding lessons in your own laboratory. This characteristic is essential when you are involved in creating and revising lessons. If you consider the difference between revising a phonograph record as opposed to an audio-tape, you become immediately cognizant of the opportunity to produce a testable lesson without having an extended commitment to the lesson, either in terms of labor or money.

---

*This quotation is revised from a statement in a mimeographed manuscript and appears as Appendix F in this report. Lassar Gotkin, Joseph McSweeney, and Fairfid Caudle, "Research in the acquisition of prereading skills using a "Talking Typewriter: "A Dialogue," 1965.

What are its limitations? Given our orientation, there are three major limitations. One of these is built into what the instrument is, i.e., an automated typewriter. For us as programers, this means that button presses stand for pairs of letters and words, but cannot stand for pictures or auditory events. Insofar as the machine is built around the typewriter, the researcher and programer are, in part, programed by that piece of equipment.

The second limitation is that the machine does not provide an ongoing record either of the responses made, correct and incorrect, or of response latencies. These are limitations from the point of view of our research interests. For us, it would have been valuable not to have to have someone looking through the one-way vision window to keep an ongoing record of these kinds of events. This is not to say that observations would be irrelevant even if automatic recording was available. The major point is that it would increase accuracy of data collection as well as lead to much less expensive and quicker arrangement of data.

The third limitation is that the machine does not branch. That is, the machine does not provide the possibility of differential feedback in relation to responses. The machine does not provide the possibility of automatic branching on the basis of errors.

In regard to these limitations, we wish to reiterate that our definition of limitations derives from our research and programing concerns. The researcher and programer need select equipment whose inner circuitry is compatible with his interests, requirements, and style. Each piece of equipment places certain parameters on those working with it. On the other hand, each piece of equipment takes on the character and personality of the persons programing. In our project we worked within the parameters of the ERE instrument. The only important machine change made was the increased flexibility of the keyboard.*

5. Content Strategy of Teaching a Structural Sequence of Reading Skills: The subject matter orientation (Chapter III, B and C) involved teaching a structural sequence of analytically oriented reading skills. In this section two types of payoffs resulting from this subject matter orientation are discussed: (a) payoffs for the learner in terms of reading performance outcomes and (b) payoffs in terms of research outcomes and practical implementation.

(a) Payoffs for the learner

In reviewing the payoffs to the learner, the question arises, "Why were children with a mean IQ of 85 able to contend with the structure of reading in so short an instructional period? After all, what was being taught is an abstract rather than a concrete approach to reading."

---

*For an interesting personal account of the interaction between a programer and a machine, see Lawrence Mace, The role of flexible laboratory equipment in verbal learning research. Ann Arbor: Center for Research in Language and Language Behavior, University of Michigan, July 1967 (Mimeo). In our work we have discussed an empirically developed set of lessons. What Mace describes, from a programer's point of view, is an empirically developed machine system in which not only the program but the machine logic was subject to revision.

Our approach to teaching the structural skill sequence involved teaching a few sounds, combining them in pairs, and then in three-letter words. It is crucial to the progression that the children are taught to blend these letter sounds and that only a few sounds are taught. Originally, in the letter name series, a problem arose, not as much in teaching the child abstract associations, as in increasing the number of such associations before he moved on to the more complex structural skills. It became evident that as the number of letters increased, children began to make errors on letters mastered earlier. Consequently, only four letters were taught to the children before they progressed to combinations of letters.

As has been pointed out, these skills were taught directly without giving children a variety of other types of experience with letter forms or more general reading skills. This approach emphasizes the structure of interrelated skills and is, therefore, consistent with Bruner's contention (1960):

> Grasping the structure of a subject is understanding it in a way that permits many other things to be related to it meaningfully. To learn structure, in short, is to learn how things are related.

Thus, in answer to the above question, we would argue that our emphasis on the "structure of reading" and structural skills helped the children to learn as they did. In elaborating on the importance of structure, Bruner identifies four general claims made for this point of view:

1) understanding of fundamentals makes a subject matter more comprehensible,
2) a century of research on human memory indicates that unless detail is placed into a structured pattern, it is rapidly forgotten.
3) an understanding of fundamental principles and ideas appears to be

the main road to adequate "transfer of training," and

4) by constantly re-examining material taught one is able to narrow the gap between "advanced" and "elementary" knowledge.

Since the approach to teaching skills in this study emphasized a structured lesson sequence, it is appropriate to question whether any evidence was obtained relating to the types of outcomes identified by Bruner.*

In regard to the first criterion, almost no evidence was available because the study was so short. However, evidence was obtained in substantiation of the point (Criterion 2) that unless detail is placed in a structured pattern it is rapidly forgotten. In the letter names series, as the number letters increased before full mastery was obtained, error rates arose and errors were even found on letters for which there were not errors at the outset. Evidence that an understanding of fundamental principles and ideas appears to facilitate adequate transfer of training (Criterion 3), was obtained both in the validation studies (Chapter 5) and in the data reported in the transfer study (Chapter 6). In the latter chapter the child's acquisition of new phonic materials is described, and it is suggested that the children had learned more than the specific content as evidenced by their ability to blend elements in new ways. Finally, as suggested in Criterion 4, by constantly re-examining and subsequently revising our instructional sequences, we gained an empirically sound, increasingly sophisiticated knowledge of reading skill development. As a result, the children were able to confront and master phonic reading skills almost two years before traditionally considered ready for such "advanced" instruction.

---

*Assessing the outcomes of this study using Bruner's criteria is of special interest because his views stem largely from cognitive psychology while the investigators, as programers, are primarily behaviorist in orientation.

A third factor which contributed to the child's mastery of the structure of reading is our use of motivational strategies. These motivational strategies maintain the child's attention and responsiveness to the letters by embedding the content in interesting contexts and thereby enable him to master the structural skills.

(b) Payoffs in terms of research outcomes and practiced implementation

The lesson sequence itself is a powerful research tool. Making use of it, a researcher can assess similarities and differences among populations. Analysis of differences may involve identifying differential problems at various levels in the sequence. For example, we were surprised to find in our own data that while the first-grade population showed a higher level of mastery of the specific content of Cycle 1 than the kindergarten population, the results of transfer to abstract blends within the first cycle were strikingly similar (Chapter VI).

Richardson has currently been working on two programs based on a detailed revision of the sequence generated in Harlem and an extension of the sequence content to include higher order phonic skills. The first of these programs involves the use of the sequence with dyslexic third- and fifth-graders. At the beginning of this program a pretest revealed that the 12 children had mastered only one or two letter sounds, a few sight words, and no phonic analysis and synthesis skills. After two months of daily tutoring sessions in the sequence, most have completed what is approximately comparable to the entire lesson sequence of our Harlem beginning reading project. The most severe problem encountered thus far with these children has been with the oral response chain leading to the blending skill. Many of the children could not hear the difference between vowel sounds when they were embedded in bigrams and trigrams. Consequently, a method to program auditory discriminations involving vowel sounds is being investigated, and a sound production branch is being developed to teach the oral response chain separately.

The second program involved adapting the sequence for use with kindergartens. This adaptation employs a group presentation format utilizing a teacher script and slide projector system; a series of supportive games; a criterion test series as a monitoring device; and remedial procedures to ensure mastery.

Thusfar, the "payoffs" described are outcomes relating to knowledge about learning, research, and teaching machine technology. Since our discipline is an applied technology, such knowledge has valuable academic implications. However, these are times in which educational researchers are being pressed with some very imminent practical questions: "What do you have, NOW?" This question is being asked with increased intensity. In surveying the present status of instructional technology, Oettinger and Marks (1968) conclude that complex teaching machine technology has limited applications now and that claims outweigh present capabilities. Discussants of that report, while pointing to exaggerations in Oettinger and Marks' assessment, are more convincing about future applications of their own work than present.

As programers, the foremost issue for us is software, i.e. the actual instructional events, whether presented by a machine or person. In our project a set of instructional events to teach a structural sequence of beginning reading skills was empirically derived. Significantly, members of our research team have developed adaptations of this instructional sequence to less expensive presentation formats.

In Chapter IV of this report McSweeney describes the PAT booklets which he developed. These booklets incorporate a system which permits paraprofessionals (and professional teachers) to teach complex beginning reading skills with a limited amount of pre-training. This system is presently being used in Newark, New Jersey; Plainfield, New Jersey; Atlanta, Georgia; and New York City.

While McSweeney has adapted the lesson sequence to a booklet format, Richardson has not only modified the sequence to make it a more precise research tool, but has put together a presentation format described earlier as part of the kindergarten program with which he has been working. This presentation system, utilizing a teacher script and slide projector, is suitable for teaching small or even large groups.

C. Discussion

Formally and informally, we are asked to explain the significance of our research. We would like to believe that a variety of persons, concerned with different aspects of learning and education, would find within the report some material of interest and relevance. We would particularly hope that the reader would begin to understand why results like ours were obtained in so short a time and with a group of children generally described as not yet ready for such instruction.

To obtain results such as ours, we have subtracted from rather than added to learning environments and learning situations. Too often too much is going on and children are unable to focus on relevant dimensions. If you wish to enable someone to come to grips with the structure of a subject matter, the first step is to remove the competing stimulation to enable him to focus on that structure. If this were not the case we would all have discovered physics because all the laws are about us all of the time. It is precisely by delimiting the intruding stimuli in the environment that the learner comes to grips with well-defined structures. However, this should not be interpreted as an inflexible advocacy of uncomplicated learning and living environments. Rather, we would argue that the most effective strategy for establishing new learning, especially that which involves complex structures, requires initial simplification and then gradual modifications. Mastery of the first levels must be obtained before going ahead to more complex levels.

The payoff of such early simplification and mastery of a structural sequence is that the children begin to give evidence of having learned how to learn rather than having merely adopted a set of associations. In regard to our target population, what was found is that a large proportion of so-called slow learners began to show evidence of the very kind of learning that is used to define rapid learners. That is, children from disadvantaged backgrounds learned skills ahead of grade level.

Many have argued that "disadvantaged" children are not ready. The programer's orientation is valuable because it tests the dimensions of the lack of readiness assertion. What becomes obvious in challenging that assertion is that large proportions of so-called "disadvantaged" children have revealed themselves to be rapid learners, and that the standard curriculum has failed to permit them to demonstrate how capable they are of learning.

References

Bruner, J. The process of education. New York: Vintage, 1960.

Mace, L. The role of flexible laboratory equipment in verbal learning research. Ann Arbor, Michigan: Center for Research in Language and Language Behavior., U. of Michigan, July, 1967 (Mimeo).

Markle, S. Empirical testing of programs. In Lange (Ed.). The sixty-sixth yearbook of the Nat. Soc. for the Study of Education. Chicago, Illinois: U. of Chicago, 1967.

Oetti[illegible], A. & Marks, S. Educational technology: new myths and old realities. Harvard Educational Review, 1968, 38, No. 4

Appendix A. Developmental History and Testing of the Program

A. Development of the Visual Sequence

During the summer of 1965 approximately 20 lessons were written and revised, and twenty-five pre-school children from the summer Head Start program worked through various portions of the 20-lesson sequence. Revisions which led to more successful lessons focused around three main areas: 1) coordinating the various instructional features of the ERE Machine System, 2) exploring motivational strategies, 3) establishing an attentional learning set in the behavior of the children.

1. Coordinating Instructional Features. The instructional features of the ERE Machine System include:

   a. a four to ten second dialogue called Card Voice
   b. a one second dialogue called Keyvoice
   c. a white card face with a red pointer
   d. a slide projector screen
   e. an electric typewriter

Most lessons, using combinations of these features, were hampered by problems of synchronization. For example, the child would receive all of the information from the Card Voice dialogue which was necessary for him to respond correctly. Nevertheless, for the correct key to open, the child had to wait until the machine finished processing the remaining, unused portions. The child often reacted to this situation with confusion or uncertainty. It was necessary to re-structure the dialogue so that it synchronized with either a ten or a four second code. Thus, when the playback ended the correct key would immediately open, ready to receive the child's response.

Coordination problems also developed between the movements of the projector and the child's response. It is possible to control the projector's movements with four different codes: turn projector on, turn projector off, move projector forward, and move projector back. Approximately $\frac{1}{4}$ second is needed for the machine to process each of these four codes. The child would be shown a picture and asked to respond to it. Before the correct key was opened the projector would be turned off and moved forward or backward to the next picture. During the $\frac{1}{2}$ second required for this processing, the correct key remained locked and the child could be observed pressing a correct key which had not yet been opened to confirm his correctness.

2. Motivational Strategies: Once a coordination of machine events and the child's response was achieved, different lesson strategies were explored. In the first lessons a game strategy was employed. For example, the red pointer which advances across the white card face could be coded to move continuously across the card face, to stop at certain letters, or to skip some letters and stop at others. In the following lesson excerpt the child is asked to play a game with the red pointer:

Sample Auditory and Visual Stimulus Played by Machine

MACHINE DIALOGUE: "I'm going to make the pointer skip along to a letter and you press the letter that it stops on. Ready?"

MACHINE EVENT: The red pointer moves several spaces across the white card face and stops at a letter. After the child's matching response, it moves across the card face again to the next letter. The child can see several letters on one line.

MACHINE DIALOGUE: "Now you watch the red pointer move to the next letter. Try to find the letter before the pointer gets to it."

Each lesson is introduced as a game for the purpose of drawing the child into a cooperative, game-like relationship with the machine. The basic skill behavior, i.e. matching letter shapes, is performed in a game-like setting. A second major lesson strategy involves the use of stories and appealing pictures. In one lesson the child listens to a story about a snake called "Mr. Charmer" who can do tricks like forming himself into letter shapes.

Sample Auditory and Visual Stimulus Played by Machine

MACHINE DIALOGUE: "Now if you'll press the letter named o you'll see Mr. Charmer make the letter o."

MACHINE EVENT:

1. The key with the letter o immediately opens.
2. After the child depresses the key for the letter o a picture of the snake formed into the letter o is flashed on the screen.

This technique has resulted in highly attentive behavior.

A third strategy involves the child in a simulated operation of the machine. It is possible to code the movement of the pointer so that each movement follows the depression of a typewriter key. The child presses a key once and the red pointer immediately moves one space. Each time the key is depressed, the pointer moves one space giving the illusion that the depression of the key is causing the movement of the pointer. Similarly, the movement of pictures on the projector screen can be coded so that each change on the screen follows the child's depression of a key. Thus the child can be asked to think of himself as an operator of the device.

Variations of each of these three strategies were employed in programing lessons, and the degree of attentive behavior produced was observed. But, the success of each lesson also depended upon focusing the child's attention upon specific aspects of the lesson environment. For example, the following lesson excerpt reveals a focusing technique which proved highly successful in introducing the child to the use of the red pointer:

Sample Auditory and Visual Stimulus Played by Machine

MACHINE DIALOGUE:	"Now look in front of you. You can see a red pointer. Watch, I'll make the red pointer move."
MACHINE EVENT:	The red pointer moves across the white card face several times and stops.
MACHINE DIALOGUE:	"Did you see the red pointer move? Watch. I'll make it move again."
MACHINE EVENT:	The child sees the red pointer move across the white card face several times.
MACHINE DIALOGUE:	"There is a hole under the red pointer. Look at the hole under the red pointer. I"ll put a letter in that hole."
MACHINE EVENT:	1. The red pointer moves to a letter. The letter is revealed to the child in the open space under the pointer. 2. Immediately after the letter is revealed, the key with the same letter is opened and ready to receive the child's matching response.

The preceding dialogue tells the child that an interesting event is about to occur. The child is placed in the position of an audience waiting for the promised performance of the machine. The reward for watching is the unique experience of seeing the red pointer click rhythmically across the card face. Similar techniques were used to draw attention to information displayed on the projector screen. The codes can be arranged so that the image on the screen flashes on and off one or more times, producing an appealing stimulus in the rhythmic clicks and flashes.

While most of the dialogue used in the lessons utilizes an adult voice, a child's voice was occasionally used to focus attention on certain aspects of a particular dialogue. The following dialogue was recorded in part by one of the kindergarten children from the non-test population:

Sample Auditory and Visual Stimulus Played by Machine

ADULT DIALOGUE: "Hi. I have another friend to play with us today. He has his own button. It has a face on it. Listen, he'll say, 'press me.' You press his button and he'll talk to you."

KEYVOICE: (one second) A child's voice, pre-recorded on a one-second track says "press me."

MACHINE EVENT: Immediately the appropriate key opens. Following the depression of the key the same child's dialogue, pre-recorded on a 10-second track, is played to the listening child.

CHILD'S DIALOGUE: "Hi, I'm going to play with you today. I'm going to talk to you (give instructions) every time you press my button.

This lesson, using a child's voice to give instructions to the learner at the machine, resulted in highly attentive behavior.

3. Attentional Set: The problem of achieving an attentional learning set and maintaining this set throughout the lesson series involved the integration of coding techniques, motivating strategies, and attention-focusing techniques. We have defined an attentional learning set as having the following components:

a. The learner waits for the machine to give him instructions before responding in any way.

b. The learner first examines the information presented by the machine.

c. The learner then scans the keyboard searching for the relevant button.

d. If an incorrect button is selected (and will not depress) the learner returns his attention to the information displayed and revises his choice.

In the first lessons produced during the summer, the experimenter sat with the child and prompted him in the task of matching single letters. A letter was displayed on the card face and the child was required to find the same letter on his typewriter keys. The following language, used by the experimenter sitting with the child, is typical of the early techniques which were relied upon to focus attention on the stimulus.

"Look up there at the red pointer. Find the same letter down here." Often the child would turn to the experimenter and seek confirmation, "Is this the one?" Just as often the experimenter would answer, "Try it and see." This procedure seriously compromised attention to the machine. The child appeared to divide his attention between the machine and the experimenter sitting with him. The feedback, "try it and see," encouraged random searching and contributed to a lack of attention to the displayed letter.

A second problem concerned the rate of new letters presented on the card face. The child would search for a letter, find and depress the proper key, and immediately be faced with a new letter. This rapid rate of stimulus presentation seemed to generate an impulsive key-pressing behavior.

A third problem involved the presentation of the same letter three or four times in succession before showing a different letter. The child could quickly sense that looking back at the stimulus was not always necessary since the same letter would be repeated. This contributed further to directing the child's attention away from the card face and onto the typewriter keys.

Our original approach to the programing of lessons required too great a reliance upon the "locked keyboard" feature of the machine to control trial-and-error responding. It was evident that this feature in and of itself was insufficient to establish the attentional learning set defined above. These early lessons produced a trial and error learning pattern characterized by a manual search for the open key. The children soon learned that the required task could be completed by merely finding and pressing the "open" key. From this pattern it was difficult to conclude that relevant learning in terms of the lesson goal was occurring.

During the latter part of the summer, five new lessons were written. The goal of these lessons was to establish an attentional learning set in contrast to a random response set. In the revised lessons only a few errors were noted for all children. Consistently, the children first listened to instructions recorded on the machine, then looked at the large letter displayed on the projector screen. They visually scanned the letters on the keyboard, occasionally looking back at the model letter on the screen, and then pressed the matching letter. No tendency to randomly press keys was noted. If a wrong key was selected, the children looked back at the model letter and then returned their attention to the selecting of another key.

The experimenter closed the door of the booth and the child was alone throughout the lesson. The first machine dialogue was the following:

> "Hello. We are going to play a game with letters. I'll show you one of my letters. You find the letter just like mine and press it. Are you ready? Here is my letter."

The letter p is projected on the screen in front of the child. Immediately after pressing the key having the same letter (p), the projector goes off and a second machine dialogue tells the child to do the same thing again. A third dialogue tells the child to look for a different letter and cautions him to look carefully.

The critical features of this lesson which are believed to account for the attentional learning set are the following:

a. The child is almost entirely dependent upon the machine's dialogue for instructions. No second party is present to compromise attention.

b. The language, "I'll show you my letter, and you find one just like mine," avoids the difficulties observed when matching behavior is elicited by more abstract language such as, "Find the same letter."

c. At no point is the child encouraged to "try it and see." The fact that other keys are locked is not revealed at this point. The dialogue emphasizes, "Look carefully at my letter first."

d. The letters used are maximally different so that visual confusions such as "d-p" are avoided.

e. Repetitious letter presentation is avoided as much as possible. After the first letter is presented twice, a different letter is presented each time to maintain dependence on the stimulus for directions.

f. Each response, in the beginning, is separated by a 10-second dialogue. The pace of new events is greatly reduced and avoids an initial expectation on the child's part that he must be prepared to respond rapidly.

Lessons 2 through 5 introduced new letters, some of which were visually confusing. Errors on these letters were consistently made by most children. The simple matching experience was insufficient in most cases to reduce such errors. Despite these errors, the attentive learning behavior described above was maintained throughout all five lessons.

While the first five lessons were being tested, an additional five were being developed. The goal of these lessons was for the child to visually match four letters in left-to-right order.

Example: Child presented with slide showing s a e t.
Child responds by first pressing s, then a, then e,
and finally t.

Revision of the ten lessons mainly involved a reduction in the number of lessons from ten to eight. Since visual matching of maximally different single letters proved to be a relatively easy task, more letters were initially introduced and less practice on all letters was required before beginning the letter-order sequence.

The purpose of the first field test was to formally validate the effectiveness of the visual series. Criterion tests for the letter-order and matching skills were devised. Table 1 shows the analysis of each test item in terms

Table 1

Percentage of Correct Responses for Each of Two Visual Matching Skills

Student Number	Pre-Test Matched Correct Letters	Pre-Test Matched Letters In Order	Post-Test Matched Correct Letters	Post-Test Matched Letters In Order
1	50.0	33.0	75.0	65.5
2	83.3	16.5	100.0	75.0
3	-	-	100.0	100.0
4	100.0	16.5	87.5	100.0
5	50.0	33.3	50.0	50.0
6	100.0	16.5	87.5	25.0
7	62.5	16.5	75.0	87.5
Mean	63.7	18.9	82.1	71.9

of two skills. This breakdown reflects greater pre-test knowledge in the skill of single letter matching and far less knowledge of letter-order prior to experience with the lessons. Gains are greater for the letter-order skill.

The visual series gave us a conception of lesson structure based upon two components: 1) its behavioral strategy, and 2) its motivational strategy. Both of these strategies refer to maximizing the occurrence of an attentional learning set toward each lesson and minimizing the occurrence of both a random response set and irrelevant responses to non-lesson stimuli. The attentional set is evident when the child first looks at and listens to the audio-visual stimulus, then visually scans the keyboard before selecting and pressing a button, the content of which is relevant to the stimulus. A random response set is evident when there is an absence of visual scanning prior to responding and the presence of motor searching to find the one key which will depress. Irrelevant responses to non-lesson stimuli are evident when the child is attracted to parts of the machine and booth (handling door and microphone, looking around booth, looking in mirrors, etc.)

B. The Development of the Letter-Name Sequence

The learning task in the initial letter-name lessons required the child first to look at the letter, listen to its letter name, and then press the button bearing the same letter. The stimulus letter remained on the projector screen while the child heard its name and while he selected the button. These lessons did not effectively focus attention on the letter-name as a means of selecting the correct button. Since the letter to be selected was always visible on the projector, the students visually matched the letter on their buttons with the letter on the projector. The name accompanying the presentation was an incidental part of the stimulus, and was not used by the child in performing the sound-symbol task. Consequently, when the letter was abruptly withdrawn from the projector stimulus during the third lesson, requiring the child to select the letter button in response to the letter-name alone, there was little evidence of correct correspondence. The problem may have been confounded by the fact that the children had to deal with five letters.

A new sequence of lessons was written using only four letters and a new response structure which attempted to focus the child's attention on the letter-name. This was done by having the child pronounce the name of the letter. The letter was presented for abrief time on the projector, the name was pronounced by the ERE, and the child echoed its name. Then the letter was withdrawn from the screen and the child was asked to select the letter-button in response to its name. While this technique apparently required the child to rely more upon the name of the letter, rather than a visual image, as an aid in correct button-selection, the response was not entirely in terms of the letter-name, since the child had recently seen an image of the letter on the screen. Occasionally a flashing presentation of the letter to be named was varied with a non-flashing, timed presentation lasting about one second. In both cases, the occurrence of the correct response appeared to be directly related to the recency of the visual presentation of the letter. We reasoned that the remaining problem was to gradually extend the length of time between the withdrawal of the visual image and the response to its letter-name.

Nine lessons were written to teach nine letter-names. Each lesson was written according to the following model:

Sample Auditory and Visual Stimulus Played by Machine

Slide shows the letter s
"the name of this letter is s. You say s..."

(child echoes s)

"Now press s"

(child presses s button while s slide is still showing)

In the above sample, note that the child is still essentially matching letter figures, since the letter continues to be projected while the child is searching for the correct button to press. In paradigm form the structure of this response looks like this:

S ⟶	R	S ⟶	R	S
-s- "this is s, say s"	Child says "s"	-s- "press s"	Child presses s button	Next letter

Each new letter was introduced in this manner. All old letters introduced in previous lessons were also reviewed in the same manner. The first 1/3 of each 7-minute lesson was devoted to the introduction of a new letter and a review of old letters in the above manner. The second 1/3 of each lesson consisted of a story or game context. For example, the child saw the letter a, pressed a, and watched either: 1) a little girl sliding down an oversized a, or 2) a snake forming himself into the sahpe of the letter a, or 3) a crow flying away with the letter a in its beak. These are brief instances from story-like sequences. The functional aspect of the lesson, i.e., the underlying behavior of selecting a letter button in response to its image, was essentially the same as in the review section of the lesson. The difference lay in the context in which this learning took place. The final 1/3 of each lesson attempted to establish a criterion level indicating response without the aid of any projected letter image on the screen.

Sample Criterion Stimuli for Abstract Indicating Response

"Press s"
(Child presses one or several buttons depending upon
degree of correctness on first choice).

"Press a"
(Child presses one or several buttons)
"press t"
"press s"

Note that in order to perform the above task, the child must recall the letter image associated with each name without the aid of any cues such as are present in the review portion of the lesson.

A variation of the button pressing response described above which is not dominant in these lessons but which later proved to be far more successful is the pointing response. The child is asked to point to a button and then he receives feedback in the form of a visual or auditory cue. This second procedure always terminates in a button pressing response after the child has either confirmed or revised his pointing selection on the basis of the feedback. The pressing strategy appeared to support the random response set and the pointing strategy supported the attentional set.

The pre and posttest scores for knowledge of the nine letter names are shown in Table 2. Pretest knowledge for the nine letters being taught was practically zero. This stands in contrast to a mean posttest score of about 42%.

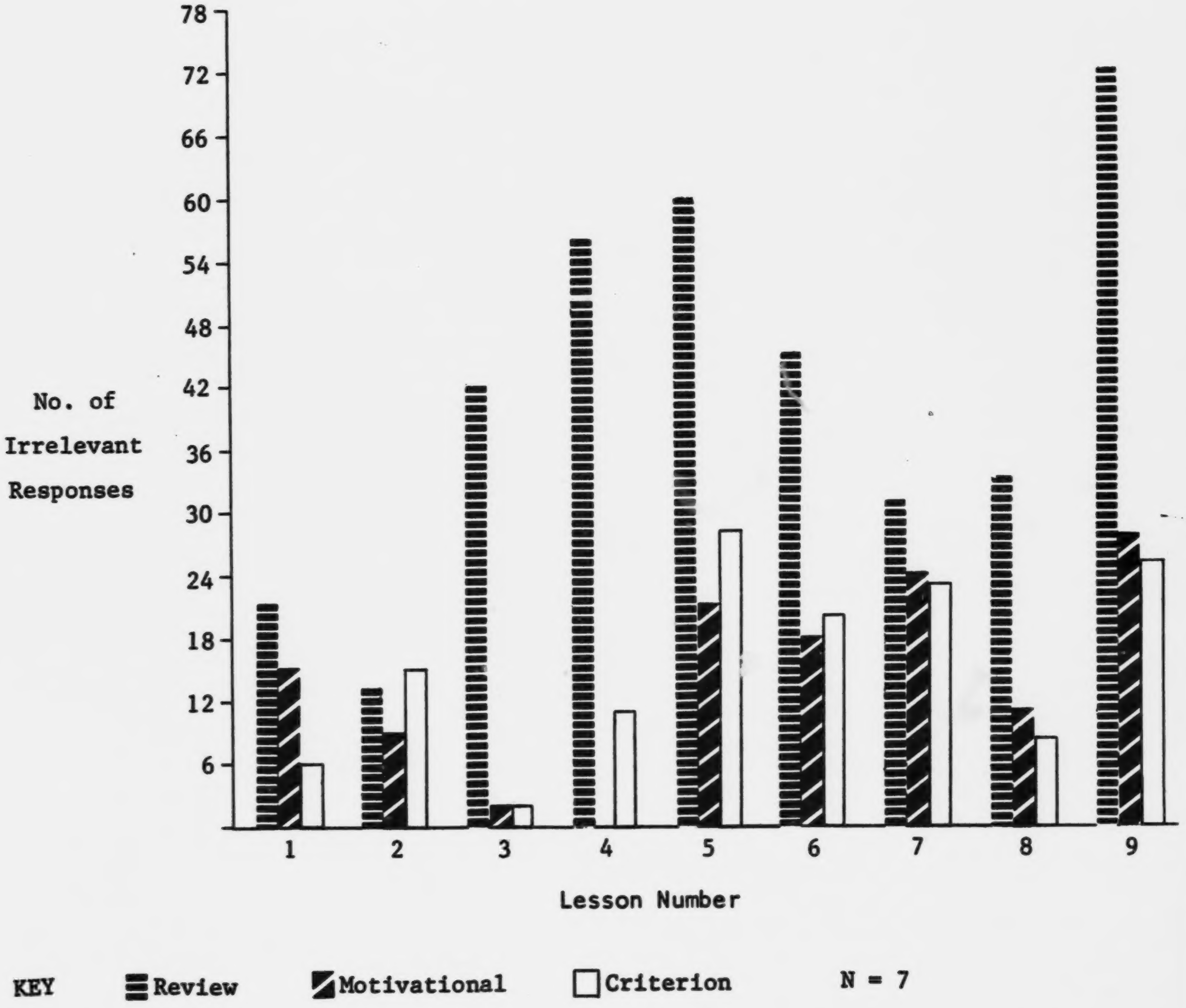
Figure 1 shows the number of irrelevant responses made in each structural section of each lesson. Two general patterns are evident from these results. First, the total number of irrelevant responses is lower in the first three lessons than in later lessons. Second, the sections including motivational strategies (story and game contexts) yielded substantially fewer irrelevant responses than did the sections not including motivational strategies.

Table 2

Percentage of Correct Responses For Nine-Item Letter-Naming Task.

Student Number	Pre-Test	Post-Test
1	11	55
2	11	47
3	0	11
4	0	77
5	0	6
6	0	69
7	0	33
8	0	64
Mean	2.75	45.25

Figure 1. Total Number of irrelevant responses in the Review. Motivational and Criterion portion of each lesson.



It seemed possible again to account for patterns of all children according to the type of learning set exhibited by the child. Two major learning sets were distinguishable:

1. an attentional learning set
2. a random response set

It was rare that a child employed the same response set throughout a lesson,and most seemed to make use of both patterns, with varying emphasis. The choice of response sets seemed to be determined by the amount and kind of corrective information available.

Each wrong button response was immediately followed by a resistance against the child's finger. This resistance caused by the locked key can be thought of as informing the child that his button selection was wrong. At this critical juncture, the children usually exhibited one of two behaviors: 1) a content response in which the children thoughtfully revised their selection by visually scanning the keyboard or 2) a motor response in which the children manually searched for one key which was "open," i.e., could be depressed. The content response is more characteristic of an attentional response set. Our conclusions were that the chief value of the locked keyboard was a negative one (informing the child that the locked key was not the correct one) and consequently, this information alone was insufficient in aiding him to select the correct key.

The need for more motivating contexts became apparent as the frequency of irrelevant behavior increased with experience on the machine. The initial novelty of the situation is sufficient motivation during the first 3 or 4 lessons to almost fully engage general attentiveness. The children seem at the same time very cooperative and suspiciously false in their setting. This effect is well known to classroom teachers during the first week or so of a new school year.

However, like the teacher who must live with a group of children for a year, the machine came to terms with the learner via the programer. We said, in effect, if you will just look and listen you will see that we can make your looking and listening more rewarding. And so we firmly established an attentional learning set to the audio-visual stimulus by means of motivational contexts.

A further area of consideration in this respect is the successful coordination of the motivating strategies with the behavioral strategies. That is, we found that attentive looking and listening did not alone secure the desired criterion behavior. It was not uncommon during the motivationally treated portion of our lessons to observe the child intently absorbed in looking and listening, and then, immediately following this attentiveness, to observe him searching out the letter button, in response to its letter name, by means of random finger movements. The attentional learning set shifted to a random motor set when the indicating or button selection response was called for. This phenomenon was attributed to two factors in the overall behavioral strategy: 1) the programed rate of information input, and 2) the predominance of the button pressing response using the locked key as feedback.

In this lesson series the children began by handling three letters and generally received a new letter each day with the exception of a few review lessons. We found that not only did the children fail to incorporate the new letters into their current repertoire, but further, that the addition of new letters interfered with the knowledge of the one previously learned. Thus the shift from an attentional set to a random set was due in part to the child's inability to cope with the total amount of information included in each lesson.

The use of the button pressing response employing the locked key as feedback is perfectly adequate as long as the child makes only a few mistakes in his selections. However, when the child encounters a locked key he essentially encounters negative information. A locked key can be thought of as equivalent to the phrase, "No, not that one." At this point it is to the child's advantage to simply search the buttons in random fashion until he encounters the correct key causing the lesson to continue. When the behavioral strategy was changed to include a pointing response to the letter button followed by positive corrective feedback and finally a pressing response, the child did not lapse into a random motor set and the attentional set was maintained.

C. The Development of the Sound Reading (SR) Series

1. The Initial SR Series: Most of the lessons in this series required the child to point to and press letters in response to their sounds. A few lessons toward the end of this series required the oral constructed response. Only two children (No. 2 & 3, Table 3) demonstrated criterion level performance of the oral response as a result of having trained mainly on the indicating response. The lower level of posttest achievement for the oral response was due to the lack of opportunity to produce this response in the lessons. The success of the indicating response, on the other hand, was due, not simply to a greater opportunity to exercise this skill, but to the controlling effects of relevant feedback. For example, the stimulus-response structure for the indicating response involved the use of a mnemonic associated with each letter. The child first learned to associate the visual letter o with the word round and the visual letter m with the word mask. After these associations were formed, it was possible to direct the child's finger to the correct button using the mnemonic association as feedback. The following sample from actual lessons shows the use of the mnemonic as corrective feedback. What the machine is prerecorded to say is written between quotation marks. The behavior of the

child is described between parentheses.

Sample Auditory and Visual Stimulus Played by Machine

Paradigm Level No.	
2.1	"Point to the letter that makes the sound *mm*..."
	(Child points to one of three letter-buttons.)
2.2	"*mm* is the letter that looks like a mask."
	(Child confirms or revises selection based upon his comparison of the word *mask* with his letter choice.)
2.3	"Now press the *mm* button."
	(Child presses button with letter *m* on it.)

After hearing "point..." in stimulus 2.1, the child selects the letter image which he thinks corresponds to the sound being played by the machine. A second later (after pointing) he hears the mnemonic phrase ("It's the *mask* letter" or "the *round* letter"). At this point he revises or confirms his response. Stimulus number 2.3 is certain to elicit a more accurate response because it asks the child to press the same letter-button which he has just pointed to. Since corrective feedback was given for the preceding *pointing* response, the following *pressing* response is usually more accurate because its content (letter image) is the same. This routine is repeated for the other single letters. The response to stimulus number 2.3 is usually correct. However, feedback is still available in the form of a locked key. If the child does press the wrong letter-button, it will not depress. The locked key tells him to revise his choice. This is not shown in the sample because correctness on 2.3 is almost 100 percent for most children.

The following table is a summary, in *paradigm* form, of the SR series.

Each paradigm represents several lessons and reveals their underlying behavioral structure. Paradigm 1 represents the beginning portion of the series; Paradigm 2, the middle and last portion of the series.

Instructional Paradigms

Level Number and Name			
1 Echo Chain	1.1 S ⟶ -m- This is mm, say mm	1.1 R Child says mm	1.2 S next letter

2 Indicating Chain	2.1 S ⟶ Point to mm	2.1 R Child points to a letter	2.2 S ⟶ mm is the mask letter	2.2 R Child confirms or revises choice	2.3 S ⟶ Press mm	2.3 R Child depresses m key	2.4 S next letter

The symbol S in these paradigms denotes what the machine shows and says to the child. In $S^{1.1}$ the machine is showing the letter m on the screen (-m-) and saying "this is mm, say mm." Each R above describes what most of our subjects usually do in response to S.

Paradigm No. 1 illustrates a simple echo response. Most children, when told what to say, will repeat the model as precisely as they can. This is the manner in which the mnemonic associations were learned, i.e., by means of simple echoes and visual matching responses. The bulk of the SR series is illustrated by Paradigm 2.

This paradigm consists of a chain of three S-R units. The first unit $(S^{2.1} \longrightarrow R^{2.1})$ elicits a pointing response from the child. The second unit $(S^{2.2} \longrightarrow R^{2.2})$ gives the child the information and opportunity to correct his pointing response. The last unit $(S^{2.3} \rightarrow R^{2.3})$ elicits a pressing response. Note that the content of both the pointing and pressing units is the same (letter *m*).

The SR series described above told us essentially that the indicating response coupled with simple echoes could not entirely support the oral constructed response. The child needed more direct opportunities to produce successful oral constructions to letter images. Although the child was required to echo the letter sounds in the presence of their images, this did not transfer to criterion performance. Criterion performance requires recall and production of the letter sound in answer to a *question* or a *command*, i.e., "What sound does this letter make?" or "Say the sound of this letter."

2. *The SR I Series*: The number of lessons based upon the oral sound response was increased. Because of its success in the SR series, the use of the mnemonic device was also increased. The child not only continued to indicate a letter by means of its mnemonic, but also orally produced the mnemonic in response to its letter image. This is illustrated in the following sample:

Sample Auditory and Visual Stimuli Played by Machine

-slide showing letter m-
"This is the mask letter, say mask letter..."
(child echoes *mask letter*)

-slide showing letter m-
"Is this the mask letter or the round letter...?"
(child says *mask letter*)...
"It's the mask letter." (machine feedback)

The oral sound lessons in this series were based mainly upon various types of echoes and multiple choice responses. These oral sound lessons followed the indicating lessons which contained the newly added oral mnemonic response. The oral sound lessons are illustrated in the following sample:

Sample Audiovisual Stimuli

-slide showing letter o-
"The sound this letter makes is oh, you say oh...
(child echoes oh)

-slide showing letter o-
"Does this letter make the sound oh or mm...?"
(child says oh)
"It's oh." (machine feedback)

The results of this series are shown in Table 3B. Again, mastery at the indicating level was generally higher than at the oral level, despite the added lessons based upon the vocal production of sounds in response to letter images. One of the causes contributing to the low level of acquisition was the use of the oral mnemonic. As the children moved from the indicating lessons where they learned to point to letters correctly, they were then required to say the mnemonic in response to the letter image. It was hoped that this requirement would somehow strengthen the oral connection between letter sound and its image. After this training, the children entered lessons which asked only for the letter sound such as mm or oh. What, in fact, happened was this: the question, "What sound does this letter make?" produced the response "It's the mask letter" or "the round letter." In other words, the trained oral association of mnemonic with letter image was interfering with the production of the letter sound. In addition to the interference of the mnemonic with oral response production, this new procedure appeared to interfere with the indicating response. As the child was being ineffectively taught to produce the mnemonic as an oral response to the visual letter, the mnemonic began to lose effectiveness as corrective feedback for the indicating response.

The programing dilemma we faced was precisely how to use the successful indicating behavior (pointing or pressing) achieved in the SR sequence to support or facilitate the acquisition of a related oral response (saying the letter sound in response to its image). The problem was intensified by the fact that the indicating response could be controlled with a high degree of success. We could guarantee almost 100% accuracy in getting the child's finger to the correct button, but were far less effective in producing the next essential behavior, a correct oral constructed response to a letter image.

3. The SR II Series: In the SR II series, the oral mnemonic was dropped as a response requirement but continued as auditory feedback for the pointing response. The child never answered the question, "Is this the mask letter or the round letter?" but heard the mnemonic as feedback in the stimulus "point to m...it's the mask letter." After correctly pressing the letter button the same letter was immediately displayed on the screen and the question was asked, "What sound does this letter make?" Accuracy of responding to this latter question was 100%. In this direct manner the problem of how to use the indicating response to support a successful oral sound response to the letter image was solved. First, the child's pointing response was controlled by the auditory mnemonic. The next stimulus was a request to press the same letter. At this point, pressing accuracy was almost 100% due to the corrective effect of the mnemonic feedback. The last stimulus in this chain was a projection of the letter image which was just pressed and a request to the child to say its sound. No errors in the oral constructed response were observed as a result of this technique. The solution of how to use the pointing response to support the oral response was simply to arrange them in successive, temporal order.

As the indicating response comes under control, the mnemonic feedback is dropped. Since criterion performance requires an oral response without preceding indicating support, a new chain based entirely upon oral responding was devised. This chain begins with a low-level, oral response in the form of a simple two-choice question. The low-level multiple choice question requires a simple selection and reproduction of one sound followed by the feedback of the correct sound. The listening response to this feedback is unobservable, but has been inferred from the children's use of the feedback. Those children who responded incorrectly to the first two-choice question have been observed to respond correctly to a criterion level question which follows the feedback.

How this chain appears to the child in an actual lesson is shown in the following sample:

Sample Audiovisual Stimuli

(Machine displays letter *m* on screen)
"Is this the letter *mm* or *oh*...?" (child
selects and reproduces one of the sounds)...

"It's *mm*" (child listens to feedback)

(-m- displayed on screen) "Say the sound of
this letter..." (child says *mm*)..."It's *mm*."

Toward the latter part of the SR II series the simple two-choice question is dropped and the criterion level response is required. (For a more complete discussion of these behavioral structures see Chapter IV, *Instructional Strategies*).

The behavioral structure of our most effective series to date can be generalized to the following form which represents both the indicating and oral chains. The content of the entire chain is the same.

$S^1 \longrightarrow$	R^1	$S^2 \longrightarrow$	R^2	$S^3 \longrightarrow$	R^3
do x	responds or doesn't respond	x is done this way	listens to how x is done	do x	does x

The correctness of the child's first active response ($S^1 \rightarrow R^1$) is doubtful. However, the correctness of the second active response ($S^3 \rightarrow R^3$) is more certain. The subject's attention to the feedback ($S^2 \rightarrow R^2$) consisting of what he should have done, increases the probability of correctness on the second active response ($S^3 \rightarrow R^3$). As the same content is repeated in this chain, the correctness of R^1 increases.

It does appear that one important requirement in guaranteeing a correct response is to design an instructional sequence so that a doubtful response of low probability is followed by a more certain response of higher probability. The role of feedback ($S^2 \rightarrow R^2$) is to make the correctness of the response which follows (R^3) more probable. In the same manner the role of R^3 is to make a repetition of R^1 more likely to be correct. The data to substantiate this point should be the subject of further research. The important point here is that the successful SR II and SR III series is based upon such a system and the above interpretation is relevant to this empirically validated system.

The pre and posttest data for the single letters are presented in Table 3. The initial sequence and the three successive revisions are represented in Sections A, B, C, and D of this table. The averaged results at the bottom of each section show clear pre-posttest gains in all cases; however, there are certain fluctuations in the posttest average which require further explanation.

The indicating average for the initial sequence (SR) is 92.8%. In SR I there is a noticeable drop in this high average to 70%. This decrease was attributed to the inability of the mnemonic to support the indicating response when the mnemonic was used in the oral response dimension. This problem was discussed in the first part of this section. Supporting the above supposition, in the SR II results where the mnemonic has been removed from the oral response dimension, the indicating average is again high, at 91.7% response accuracy. The SR III results were obtained from Head Start children. Due to the short duration of this program and the irregular attendance of the children, the group was moved as quickly as possible through the sequence. This procedure resulted in a slight drop in the indicating average to 84.4%. It is felt, however, that this drop was caused by the failure of a single S, #26, to acquire the indicating skill.

The averaged posttest results for SR in the oral response show definite gains; however, the results are far from a desired 100% criterion. In SR I the oral response average was not improved because use of the mnemonic did not support the oral response. However, the 100% results on SR II reflect the success of the indicating response when it was used to support the oral response. The drop in the averaged results shown by the 84.4% in SR III was attributed to the previously mentioned problems with the use of Head Start children.

Table 4 shows the pre and posttest results for the unitary response. The indicating response average for blended pairs in SR I is higher than the average for the single letters (see Table 3). This probably reflects the fact that the mnemonic was not used with blended pairs, thus the indicating response was freed at this level from the burden of the use of the mnemonic in the oral response dimension. The high indicating response scores for all revisions reflect the use of the same techniques found effective for single letter acquisition. The averaged results of pupils show the increasing effectiveness of the successive revisions. It should be noted, however, that the SR III results, obtained from the Head Start Ss, may not reflect the full power of this section of the revision.

Table 3

Single Sounds

Student Number	Pretest		Posttest	
	indicate	oral	indicate	oral
	A. SR (Initial Sequence)			
1	33.3%	0.0%	100.0%	50.0%
2	0.0	0.0	100.0	100.0
3	0.0	0.0	100.0	100.0
4	0.0	0.0	100.0	66.6
5	0.0	0.0	66.6	0.0
6	0.0	0.0	83.3	66.6
7	0.0	0.0	100.0	66.6
$\overline{X}$	4.8	0.0	92.8	64.3
	B. SR I (First Revision)			
8	33.3%	0.0	100.0%	100.0%
9	0.0	0.0	33.3	33.3
10	33.3	0.0	0.0	0.0
11	33.3	0.0	100.0	66.6
12	0.0	0.0	100.0	100.0
13	0.0	0.0	100.0	83.0
14	33.3	0.0	33.3	66.6
15	100.0	0.0	100.0	66.6
16	0.0	0.0	33.3	0.0
17	0.0	0.0	100.0	66.6
$\overline{X}$	23.3	0.0	70.0	58.3
	C. SR II (Second Revision)			
18	0.0	0.0	66.6	100.0
19	0.0	0.0	100.0	100.0
20	33.3	0.0	100.0	100.0
21	0.0	0.0	100.0	100.0
$\overline{X}$	8.4	0.0	91.7	100.0
	D. SR III (Third Revision)			
22	50.0	0.0	100.0	100.0
23	0.0	0.0	75.0	75.0
24	25.0	0.0	100.0	75.0
25	25.0	0.0	75.0	75.0
26	25.0	50.0	25.0	50.0
27	25.0	0.0	100.0	100.0
28	25.0	0.0	100.0	100.0
29	50.0	25.0	100.0	100.0
$\overline{X}$	28.1	9.4	84.4	84.4

Table 4

Unitary Response

To Two and Three Letter Combinations

Student Number	Pretest indicate	Pretest oral	Posttest indicate	Posttest oral
SR I (First Revision)				
8	- *	- *	80.0%	75.0%
12	-	-	100.0	75.0
15	-	-	80.0	43.7
17	-	-	100.0	62.5
$\overline{X}$	-	-	90.0	64.1
SR II (Second Revision)				
18	- *	- *	60.0%	83.3%
19	-	-	83.3	- *
20	-	-	100.0	81.8
21	-	-	100.0	50.0
$\overline{X}$	-	-	85.8	71.7
SR III (Third Revision)				
24	- *	- *	100.0%	100.0%
25	-	-	66.6	40.0
26	-	-	100.0	100.0
27	-	-	66.6	40.0
28	-	-	100.0	100.0
$\overline{X}$	-	-	86.5	76.0

D. Development of the Blending Sequence

Much of our work in the blending sequence was directly drawn from Silberman's work with first grade children. The structure of the Silberman blending sequence required the child to produce an echoic response which consisted of repeating a chain of letter sounds presented on the auditory level, followed by the application of this echoic chain to the visual image representing the sounds in the chain. For example, the required blending response was to look at a three-letter word, say the sound of the first two letters, then the sound of the last letter, and finally, the sound of the word.

Example: Visual Blend

Visual Stimulus	Auditory Stimulus	Child's Response
pat	Say the sound of the first two letters, the last letter, and then say the word.	"pa, t, pat"

In order for the child to acquire this complex behavior, Silberman preceded this step with a step he called the echoic chain. Before looking at a visual word, the child repeates the sounds in the word and the sound of the whole word. This echo serves as the behavioral basis for later phonetically analyzing and synthesizing the graphic word image.

Example: Step 1, Echoic Chain

Visual Stimulus	Auditory Stimulus	Child's Response
1. none	say pa, t, pat	"pa, t, pat"
2. none	pa, t, pat	"pa, t, pat"
3. none	pa, t, pat	"pa, t, pat"
4. none	say mo, m, mom	"mo, m, mom"

Silberman's sequence actually used a vc pattern and a perceptual set which required the children to look at the first letter and then the last two letters as separate units. The set shown here (first two, last one) is for illustrative purposes only.

Additional word sounds are introduced into the list of echoes, until the child has practiced repeating all the sounds in all the words for which he must produce the final visual blending response in Step 2 below.

Example: Step 2, Visual Blending Response

Visual Stimulus	Auditory Stimulus	Child's Response
1. pat	Say the sounds of the first two letters, the last one, and then say the word.	"pa, t, pat"
2. pat	Now just say the word.	"pat"
3. mom	Say the sounds of the first two letters, the last one, and then say the word.	"mo, m, mom"

The examples given here are gross steps, containing several sub-steps in the actual lesson sequence.

The basic structure of the blending sequence shown above was worked out by Silberman using first grade children. The problem which our kindergarten children had was not in the structure but in the sequencing. Silberman's sequencing called for the echoing (Step 1) of all trigrams followed by the visual blending of all trigrams (Step 2). This sequence did not produce a sufficient number of correct responses in our population and resulted in long latencies. It appeared that the value of the echo as a trigger in generating the visual blending response was diluted by the sequencing which stressed recall of an echoic chain from among several chains. Instead of having the children echo all the trigrams before proceeding to Step 2, the visual blending response, we rewrote the sequence so that the auditory echo for each trigram immediately preceded the visual blending response for each corresponding image. In other words, the echoes and visual blends were redistributed so that one blend followed a series of echoes for that blend.

Example: Echoes and Visual Blends in Combined Sequence

Step	Behavior	Visual Stimulus	Auditory Stimulus	Response
1.	echo	none	say pa, t, pat	"pa, t, pat"
2.	echo	none	say pa, t, pat	"pa, t, pat"
3.	blend	pat	say the sound of the first two letters, the last one,and then say the word.	"pa, t, pat"
4.	echo	none	say sa, m, sam	"sam, m, sam"
5.	echo	none	say sa, m, sam	"sa, m, sam"
6.	blend	sam	say the sound of the first two letters, the last one, and then say the word.	"sam, m, sam"

The effect of practicing the echo immediately prior to the visual blend increased the likelihood of the child's using the echoic chain in analyzing the visual image (producing the first and last sounds) and in synthesizing the sounds (saying the whole word).

Additional modifications were made in Silberman's sequence and proved effective for the remaining developmental test children. This sequence was then used in the larger Validation Study of 32 kindergarten children and

33 first grade children.

As a result of having Silberman's sequence available in detailed specification form, the project staff saved at least a year of developmental effort.

Appendix B. The Criterion Test

The criterion test (the pre- and post-test) consisted of ten sections. Each section was divided into two or three parts except for Section X (Transfer Test) which consisted of a single part. Each section and its parts will be presented in outline form with a brief description of each part and an example of a single trial within that part.

I. Warm-Up Section

Part 1: Oral Name Response

The child was shown a series of six pictures of familiar objects and was asked to name each picture.

Example:

Visual Stimulus: Picture of a dog.

Tester says: What is this?

Expected Response: A dog.

Part 2: Indicating (pointing) Response

The child was shown six different sets of four pictures each and was asked to point one of the four.

Example:

Visual Stimulus:	cat	dog
	boy	horse

Tester says: Point to the dog.

Expected Response: Child points to dog.

II. Sound-Symbol Correspondence: Single Letter Section

Part 1: Oral Constructed Response

The child was shown a series of six single letters (m, o, p, a, t, s) and was asked to say the sound of each letter.

Example:

Visual Stimulus: m

Tester Says: What sound does this letter make?

Expected Response: m (letter sound)

Part 2: Indicating Response

Child was shown six different sets of four letters each and was asked to point to one of the four, given the sound.

Example:

Visual Stimulus:

o	p
m	s

Tester Says: Point to the letter that makes the sound m.

Expected Response: Child points to m.

III. Single Letter--Double Letter Discrimination

Part 1: Indicating Response

Child was shown four different arrangements of the elements m, s, mo, and so, and was asked to point to one element on each trial.

Example:

Visual Stimulus:

mo	s
m	so

Tester Says: Point to mo (as in mom).

Expected Response: Child points to mo.

Part 2: Oral Sound Selection

Child was shown mo, so, m, and s successively and was asked to repeat one of two sounds for each stimulus

Example:

Visual Stimulus: so

Tester Says: Is this sss or so?

Expected Response: Child says so (as in sock).

IV. Sound-Symbol Correspondence: Unitary Response to Bigram

Part 1: Unitary Indicating Response

Child was shown three different arrangements of the three bigrams mo, so, po, and was asked to point to a different pair on successive presentations.

Example:

Visual Stimulus: mo

po so

Tester says: Point to po (as in pot).

Expected Response: Child points to po.

Part 2: Oral Selection

Child was shown the pairs mo and po successively and asked to repeat one of two sounds for each bigram.

Example:

Visual Stimulus: mo

Tester Says: Is this mo or po?

Expected Response: Child says mo.

Part 3: Oral Construction

The child was shown the pairs mo, so, and po successively and asked to say the sound of each pair.

Example:

Visual stimulus: po

Tester says: Say the sound.

Expected Response: Child says po.

V. Letter Order--Two Letters

Part 1: Indicating Response

Child is shown mo and asked to point to the first letter.

Child is then shown po and asked to point to the last letter.

Example:

Visual Stimulus: mo

Tester says: Point to the first letter.

Expected Response: Child points to m.

Part 2: Ordered Oral Construction

Child is shown mo and asked to say the sound of the first letter. Child is then shown po and asked to say the sound of the last letter.

Example:

Visual Stimulus: po

Tester says: What sound does the last letter make?

Expected Response: Child says o.

VI. Bigram Blended Response:

Part 1: Ordered Oral Selection

Child is shown bigrams mo, so, sa, and ma successively. For each bigram the child was asked to say the sound of the first and last letter, then he was asked to repeat the blended sound from one of two presented.

Example:

Visual Stimulus: ma

Tester says: Say the sound of the first and the last letter.

Expected Response: Child says m, a.

Tester says: Is it pa or ma?

Part 2: Ordered Oral Construction

Child was shown the bigrams mo, sa, ma, po, pa, and so successively and was asked to say the sound of the first letter, the last letter, and the sound of the blended pair in a single response chain.

Example:

Visual Stimulus: sa

Tester says: Say the sound of the first, the last, and both together.

Expected Response: Child says s, a, sa.

VII. Unitary Response to Trigrams

Part 1: Indicating Response

Child was successively shown the words mom and pop contained in a group of three words and was asked to point to the word mom or pop.

Example:

Visual Stimulus: sam pop
pot

Tester says: Point to the one that says pop.

Expected Response: Child points to pop.

Part 2: Oral Selection

Child was shown the words mom and pop successively and was asked "Is it mom or pop?" for each word.

Example:

Visual Stimulus: mom

Tester says: Is it mom or pop?

Expected Response: Child says mom.

VIII. Letter Order--Perceptual Set for Trigrams

Part 1: Indicating Response

Child was shown three loose felt letters. He was asked to select the first two letters. The letters were then rearranged and the child was asked to select the last letter.

Example:

Visual Stimulus: mop (individual felt letters)

Tester says: Give me the first two letters.

Expected Response: Child picks up m and o and gives them to tester.

Part 2: Ordered Oral Construction

Child was shown three letters and was asked to say the sound of the first two letters and then say the sound of the last letter.

Example:

Visual Stimulus: mos

Tester says: Say the sound of the first two letters and then say the last.

Expected Response: Child says mo, s.

IX. Trigram Blending

Part 1: Ordered Oral Selection

Child was shown the words mop, sam, and pot successively. For each word he is asked to say the sound of the first two and last letter, and then he is asked to repeat one of two words that corresponds to the visual stimulus.

Example:

Visual Stimulus: mop

Tester says: Say the sound of the first two and the last.

Expected Response: Child says mo, p.

Tester says: Is it sam or mop?

Part 2: Ordered Oral Construction

Child was shown the seven trigrams, mom, sam, pat, pop, pot, sat, and mop successively and was asked to say the sound of the first two, the last, and the whole word.

Example:

Visual Stimulus: pat

Tester says: Say the sound of the first two, the last, then say the whole word.

Expected Response: Child says pa, t, pat.

X. Transfer Test--Trigram Blending

The child was shown the seven trigrams mos, sot, pom, pas, sos, mat, and sap successively and was asked to say the sound of the first two, the last, and the whole word.

Example:

Visual Stimulus: sap

Tester says: Say the sound of the first two, and the last; then say the whole word.

Expected Response: Child says sa, p, sap.

Appendix C. Basic Research

Ours is essentially an applied research project. Nevertheless, in the process of developing and testing lesson sequences important issues related to basic research do arise. Two such basic research issues were deemed important enough to design and conduct specific pilot studies.

The first study explores the question of feedback, and asks "What kinds of feedback are effective?" While the answers to this question are of great importance generally in the design of equipment, it has specific relevance in our work. One of the basic feedback mechanisms in the ERE instrument is the locked keyboard. The locked keyboard operates so that only the one key will depress; the remainder of the keys are locked. If the learner presses a key which does not represent the correct response, it will not depress. In terms of Moore's theory this type of feedback is deemed to be sufficient. In our work we have found this to limit learning as well as our programing techniques. Richardson's study in this report compares the feedback of the locked keyboard with positive feedback.

Earlier in this report it was pointed out that educators often speak of attention span as a characteristic of the individual. Without denying this, it is still possible to treat attention as a variable dependent upon aspects of instruction. Motivational strategies have been discussed earlier in this report. McSweeney has documented the effects of motivational contexts on attentional behavior. His study demonstrates the effectiveness of such techniques in reducing irrelevant behavior.

A. Effects of Two Types of Feedback On the Acquisition of Sound-Symbol Correspondence: The Problem of the Locked Keyboard as a Feedback Mechanism

In several of our progress reports as well as other places we have discussed the problem of the locked-key mechanism as a limiting feature of the ERE. The problem, as we have presented it, is simply that the exclusive use of the locked-key as feedback for a sound-symbol indicating response produces inattention, random pressing behavior, and a resultant failure to acquire the sound-symbol indicating skill. We have found it necessary to "program around" this problem by training a pointing response which may be followed by positive corrective feedback in the form of a visual image or the structural mnemonic. This problem and its solution were mainly the result of careful observation rather than controlled experimental analysis.

A pilot study was designed to experimentally compare the behavior produced by locked-key feedback with that produced by positive verbal feedback. Negative locked-key feedback is the stimulus of the locked key following an incorrect pressing response which tells the child, "Not that one." Positive verbal feedback is a verbal stimulus following an incorrect pointing response which has previously been demonstrated to control that response. It was hoped that, in addition to verifying our hypothesis regarding the superiority of positive feedback, the study would provide further insight into the acquisition of the sound-symbol skill and the role of positive corrective feedback.

1. Subjects and Procedure: Three symbols were printed on the three keys exposed to the child: a circle, a square, and a star. The sounds associated with each symbol were chosen for dissimilarity. The circle was associated with a squeaking sound, the square with the sound of a jingling bell and the star with a single note on a xylophone.

Two groups of 5 children were selected from the Head Start program at

P.S. 175; however, two of the children from Group I failed to complete the experiment due to absences. The experiment was conducted in four sessions (See Table 1) consisting of a machine skills session, two sound-symbol training sessions, and a final criterion session. Both groups received the same machine skill training on Day 1. On Day 2 and 3, Group I received sound-symbol training with only the locked-key as feedback for an incorrect response associated with that sound. Only the correct key operates, so, if the child makes an error he finds the key locked and the machine waits for the child to depress the correct key before initiating the next trial.

Group II also received sound symbol training on Day 2 and Day 3, but verbal feedback was provided for an incorrect indicating response. According to this procedure the S hears the sound and points to the key. If he is pointing to the correct key he is immediately allowed to press it. If the S points to an incorrect key he hears the verbal cue ("circle," "square," or "star") associated with the symbol and he is allowed to press the key only after correcting his pointing response.

Day 4, the criterion session consisting of 60 trials, was identical for both groups. The procedure for Day 4 was the same as the procedure described for Day 2 and Day 3 for Group 1, using the locked key as feedback for an incorrect response. All sessions were observed and all pointing and pressing responses were recorded by the observer.

2. Results: The results for 60 trials of the final criterion session are shown in Table 2. The data report the number of trials on which the S's first key selection was correct. The mean and variance were computed for each group. An F ratio was computed to check the assumption of homogenity of variance and was found to be not significant at the .05 level. So a t-test for the difference between two means of independent samples was performed with a pooled

variance. The t value of 2.74 was found to be significant at better than the .025 level.

In addition to the difference in criterion performance between the two groups, a few other points should be noted. S #3 of Group I got 14 out of 60 correct which is below the chance level of 20 correct; however, the other two Ss in this group performed better than chance, indicating that some measure of learning had occurred. Group II appears to be divided into two distinct clusters. S #3 shows a perfect score of 60 while S #4 missed only three out of 60. In contrast to this, the other three Ss of Group II have scores ranging from 40 to 48. These scores, although higher than Group I scores, are less than perfect.

3. Discussion and Conclusions: The data clearly indicate that performance following positive corrective feedback is superior to that following negative feedback, at least for the case involving sound-symbol correspondence for small amounts of material. The results do not show, however, that learning does not occur following negative feedback as evidenced by the apparently better-than-chance performance of two of the group I Ss. This leads to the question of just what has been learned or what is interfering with performance. The answers may be related to the less-than-perfect performance of the three Group II Ss, and they may also be related to error distributions, latency distributions, and retention measures. Thus, one of the most important aspects of this study is its implications for research and for a deeper analysis of the sound-symbol skill.

Another important aspect of this study is that it arose from developmental programing research. We discovered a problem with the negative locked key feedback of the ERE machine and developed a solution through experimental programing techniques. We have not been able to expand our understanding of this

Table 1

Outline of Experiment

	Group I	Group II
Day 1	Machine skill training	Machine skill training
Day 2	Sound-symbol training (locked-key feedback)	Sound-symbol training (verbal feedback)
Day 3	Sound-symbol training (locked-key feedback)	Sound-symbol training (verbal feedback)
Day 4	Criterion (locked-key feedback)	Criterion (locked-key feedback)

Table 2

Number of Trials in which the First Choice was Correct out of 60

Group I		Group II	
Student Number	Number Correct	Student Number	Number Correct
1	37	1	43
2	32	2	48
3	14	3	60
		4	51
		5	40
Mean	27.7	Mean	49.6
s^2	146.33	s^2	75.3

P = 1.94; $P > .05$

t - 2.74; $P < .025$

solution through formal research. The results of this study, and of others like it, may be used to supplement our developmental research by indicating more efficient and effective ways of applying our developmental discoveries.

B. The Effect of Motivational Contexts on Attention in Younger Learners

This pilot study explored the effects of motivational contexts on learner attention in a machine instructional setting. An extended discussion of the range of motivational contexts used in the lessons is contained in Chapter IV.

Eight sessions (1-8) requiring visual matching of three plain letter shapes by means of pointing comprised a minimal context (Table 4). Eight additional sessions (9-16) required the same task of visually matching identical letter shapes but involved a greater variety of stimulus and response modes. Sessions 9-16 comprised the motivational context (Table 4). The total time that each of five students engaged in irrelevant behavior was recorded for each session. The difference between treatments was significant at the .05 level and barely significant at the .025 level (Tables 3 and 5).

Subjects were kindergarten children in Harlem at P.S. 175. Pretest knowledge of the task (visual matching) was 100% for each S. Each session was five minutes (machine time), one session per day, given on successive days. All the lessons were administered by the ERE machine. The child was alone in a 4' x 4' x 8' room. Irrelevant behavior included looking in mirrors, looking around booth away from machine, handling door or door knob (located behind child), getting out of chair, handling machine parts unrelated to lesson (microphone, panels, lucite housing). The duration of irrelevant activity was cumulatively recorded by means of a stopwatch, E observing outside the room through one-way mirrors.

In the first eight sessions, the child was presented with a plain letter shape on the projector screen and was asked to point to the same letter on his keyboard. An example of this form is shown in Table 4 (minimal context).

The machine advanced to the next letter immediately after the child responded. In sessions 9-16, the same letters and matching task were placed in varying contexts designed to engage the child's interest. Instead of pointing to a letter, the child picked up a rubber stamp and stamped the matching letter, or picked up a felt pen and colored it. In addition to motivational treatment of the response mode, such as stamping, coloring, or pressing buttons, the letter the child looked at on the projector screen was also motivationally treated. Occasionally the child saw the letter-to-be-matched as a picture of a snake formed into the letter shape. Examples of other treatments are shown in Chapter IV of this report.

The basic data, duration of irrelevant behavior for each session, are summarized in Table 3. For sessions 1-8 the mean duration for each student is quite variable, reflecting individual predispositions to listen and perform attentively or engage in irrelevant behavior. S #1 and #4 exhibited the least amount of inattention to the task, while the remaining students engaged in a substantial amount of irrelevant behavior (I.B.).

The duration of I.B. increases for all students as the sessions are repeated. S #4 did not begin to become inattentive until session 4, and by session eight his I.B. had increased to 40 seconds. This is a typical effect. Children are normally most attentive and display the least amount of I.B. during the first three sessions. The novelty of the machine setting seems to account for this effect. Thereafter, I.B. begins to rise for all children observed.

The effect of sessions 9-16 is evident over all students. I.B. decreased rapidly during session nine, below each mean for the previous sessions, and continues on a general decline for all students as the motivational sessions continue.

The purpose of the exploratory study was to verify the fact that the motivational techniques used in these sessions could significantly reduce irrelevant behavior for all subjects, resulting in increased attention to the audiovisual stimulus. A known task (matching letters) was purposely chosen to control any influence which a more unfamiliar task may have upon attention.

Table 3

Duration, In Seconds, Of Irrelevant Behavior For Each of Sixteen Sessions

Minimal Context Visual Matching

		Session Number								
		1	2	3	4	5	6	7	8	Mean $\overline{X}$
Student Number	1	7	14	23	30	20	28	31	35	24
	2	64	52	91	105	50	105	80	85	79
	3	27	12	30	35	37	85	145	175	68
	4	0	0	0	4	9	13	35	40	13
	5	80	86	48	143	117	115	110	120	102

Motivational Context Visual Matching

		Session Number								
		9	10	11	12	13	14	15	16	Mean $\overline{X}$
Student Number	1	5	0	0	6	0	0	0	0	1
	2	37	45	15	30	0	0	4	0	16
	3	2	4	10	0	0	0	6	0	3
	4	0	0	0	0	0	0	0	0	0
	5	0	0	10	0	0	22	0	0	4

Table 4

Minimal and Motivational Contexts

	Minimal		Motivational
1.	Look at this letter (Slide showing lower case m) Now point to your letter on your button just like mine. (S points to m)	1.	Pick up the stamp that has this letter on it (slide of rubber stamp with m). Make that letter on your card. (S presses stamp on card making m imprint.)
2.	Now look at this letter (Slide showing o) Point to this letter on your button. (S points to o)	2.	Pick up the card that has this letter on it (slide showing o). Now take your pen and color that letter (S colors letter o with felt pen)

Table 5

Comparison of Each Student's Mean Score for Sessions 1-8 and 9-16

Source	SS	df	MS	F
Between Treatments	6864	1	6864	11.69
Between Students	3475	4	869	1.48
Residual	2347	4	587	1.48
Total	12686	9		

$p < .05$

Appendix D. A Statement of the Program's Skill Objectives, Content Sequencing, and the Behavioral Structures Used in Achieving the Objectives.

The aim of this appendix is to present a full statement of what was done within the program to obtain lesson-criterion behavior from the children. Three different but related dimensions of the program will be presented. The first is a sequential statement of the program objectives with specifications of the required behavior and an example of the behavior drawn from the lesson sequence. This will be followed by a table showing the content specified within particular lessons and a specification (by reference to the objectives section) of the objectives included in these lessons. Finally, a concise statement of the behavioral structures in paradigm form will be presented to illuminate the details of the acquisition of the behaviors specified in the objectives section of this appendix.

A. Objectives with Specifications and Examples

The objectives have been organized into criterion objectives and supportive objectives. The criterion objectives state the final behavioral objectives of the program and the supportive objectives describe behaviors which serve as program mediators in the attainment of the criterion objectives. An exception to this format are the entry objectives (machine-working skills) which may be viewed as the entering skills and not necessarily an integral part of the phonics program.

Objectives With Specifications and Examples

1. Entry Objective: Machine working skills, button pressing, button pointing

Specification: Child looks at, points to and presses typewriter key in response to the words, "Look at, point to or press the button."

2. Criterion Objective: Sound to symbol correspondence, indicating the letter image in response to its sound

Specification: Given the letter sound, the child points or presses one of three letter images.

Example: "Point to the letter that makes the sound m."

a) Supportive Objective: Letter matching

Specification: Given a letter image presented on a slide projector screen, and the instructions, "Point to (or press) the letter on your button just like the letter in my picture," the child responds by pointing to or pressing the matching letter button.

Example:

Visual -m- (projected letter on screen)

Auditory "Point to the letter on your button that's just like the letter in my picture." (Child points to letter button with -m- on it.)

b) Supportive Objective: Sound to symbol correspondence, mnemonic matching

Specification: Given the words, "Point to the round letter on your button," child selects the letter o from among 3 letter buttons (m, o, p) and points to it.

Example:

Auditory: "Point to o...it's the round letter."

3. Criterion Objective: Symbol to sound correspondence, oral constructed response to letter image

Specification: Given the letter image, the child orally produces its sound.

Example:

Visual: -p-

Auditory: "Look at this letter. Say the sound of this letter."

a) Supportive Objective: Echoing, oral response

Specification: Given an auditory model of some sound, the child orally repeats the sound.

Example:

Visual: -o-

Auditory: "The sound this letter makes is o, you say o"...(Child says o)

b) Supportive Objective: Delayed echo

Specification: Given the letter image after some recent response involving that letter, the child orally produces its letter sound.

Example:

Recent Response: Abstract indicating to o

Visual: -o-

Auditory: "Look at this letter. Say the sound of this letter."

c) Supportive Objective: Symbol to sound correspondence, oral selection response to letter images

Specification: Given a letter image and an auditory model of two letter sounds, the child selects and reproduces one of the sounds.

Example:

Visual: -p-

Auditory: "Does this letter make the sound m or p?"

4. Criterion Objective: Unitary indicating response to two letters, sound to symbol correspondence, indicating a two-letter combination in response to its blended sound

Specification: Given the blended sound mo (as in mom), child points to or presses one of the three buttons, each having a different two-letter combination (bigram) (mo, so, po).

Example: "Point to the button with mo on it."

a) **Supportive Objective**: Sound to symbol correspondence, single sound cueing for bigram indicating.

Specification: Given the two single sounds, the child selects and points to bigram.

Example: "Point to mo, it's the one with m and o in it."

5. **Criterion Objective**: Unitary oral response, symbol to sound correspondence, orally producing the blended sound of a two-letter (bigram) image.

Specification: Given a two-letter image and an auditory request to say the sound of both letters together, the child orally produces its blended sound.

Example: -ma-
"What sound do these two letters make?"

a) **Supportive Objective**: Echoing, oral response (see 3a)

b) **Supportive Objective**: Delayed echo (see 3b)

c) **Supportive Objective**: Oral selection (see 3c)

6. **Criterion Objective**: Bigram blending, oral blending, response chain

Specification: Given the visual bigram, the child orally produces the response chain consisting of the sound of the first letter, the last letter and the blended sound of the pair.

Example:

Visual: -mo-

Auditory: "Say the first, and last, and both together."

a) Supportive Objective: Letter order, ordered oral construction

Specification: Given the visual bigram, the child orally produces the sound of the first letter and the last letter.

Example:

Visual: -mo-

Auditory: "Say the sound of the first and last letters."

Response: "m, o."

b) Supportive Objective: Echoic chain, letter blending

Specification: Given an auditory model of an ordered series of letter sounds, the child orally repeats the series in the same order.

Example: "Say m, a, ma." (Child says, "m, a, ma.")

c) Supportive Objective: Auditory blending

Specification: Given two phonic sounds, the child orally produces the ordered blend of the two sounds.

Example: "I'll say the first and last and you say both together. Ready? m, o." Child says, "mo."

7. Criterion Objective: Trigram blending

Specification: Given the visual trigram, the child orally produces the blended sound of the first two letters, the sound of the last letter and the blend word.

Example:

Visual: -mom-

Auditory: "Say the sounds."

Response: "mo, m, mom."

a) Supportive Objective Perceptual set

Specification: Given the visual trigram, the child produces the blended sound of the first two letters and the sound of the last letter.

Example:

Visual: -mom-

Auditory: "Say the sound of the first two letters and the last letter."

Response: "mo, m."

b) Supportive Objective: Echoic chain

Specification: (See 6b)

Example:

Auditory: "Say mo, m, mom."

Response: "mo, m, mom."

c) Supportive Objective: Auditory blending

Specification: (See 6c)

Example:

Auditory: "mo, m"

Response: "mom"

B. The Sequence of Lesson Content and Objectives

In the following table the letter content is shown as it appears in the actual sequence of lessons. The objectives achieved with respect to the specific content are shown in the program objectives column by numbers which refer to Section A of this appendix. The actual steps used in attaining these objectives will be shown in the final section (C), and are referenced in this table in the column labeled "Behavioral Structures." The specific paradigms used are referenced here by number.

Lesson Number	Content	Program Criterion	Objective Supportive	Behavioral Structure
1	Machine working skills (pointing, pressing)	1		1
2	m, o, p		2a	2
3, 4, 5	m, o, p		2b	3, 4
4, 5, 6, 7	m, o, p	2		4, 5
8 - 14	m, o, p	3	3a, 3b, 3c	6, 7, 8, 9, 10, 11
15, 16	m, o, p, s	3	3a, 3b, 3c	6, 7, 8, 11, 13
17, 18, 19, 20	m, o, p, s, mo, po	4	4a	12, 13, 14
21 - 28	m, o, p, s, mo, po, so	5	5a, 5b, 5c	14, 15, 16, 17, 18
29 - 34	mo, so, po		6a	19, 20, 21
35 - 38	mo, so, po	6	6b, 6c	22, 23, 24, 25, 26
39 - 41	m, o, p, s, a	3		6, 7, 8, 11
42	mo, ma	6	6b, 6c	22, 23, 24, 25, 26
43	po, pa	6	6b, 6c	22, 23, 24, 25, 26
44	so, sa	6	6b, 6c	22, 23, 24, 25, 26
45	mo, ma, po, pa	6	6b, 6c	22, 23, 24, 25, 26
46	mo, ma, po, pa, so, sa	6		22, 23, 24, 25, 26
47		3		6, 7, 8, 11
48, 49	mom, sam, pot		7a	27, 28
51, 52	mom, sam	7	7a, 7b	29, 32
53	mom, sam, pot	7	7a, 7b	29, 30, 32
54	mom, sam, pat	7	7b, 7c	29, 30, 31, 32, 33
55, 56	mom, sam, pot, pat	7	7b, 7c	29, 30, 31, 32, 33
56, 57	mom, sam, pot, pat, sat	7	7b, 7c	29, 30, 31, 32, 33
58, 59	mom, sam, pot, pat, sat, pop	7	7b, 7c	29, 30, 31, 32, 33
60-62	mom, sam, pot, pat, sat, pop	7	7b, 7c	29, 30, 31, 32, 33

C. The Behavioral Structure

The structure of each stimulus is precisely what is said and shown to the child by the machine and is denoted by S. What the child usually does in response to S is denoted by R.

A behavioral structure can be thought of as a rule which defines the stimulus-response form by which a wide variety of content may be taught. The use of the S-R paradigms here is not intended as a technical application of the principles of behavior from operant or Pavlovian paradigms. An application of the Pavlovian paradigms does not seem justified by the nature of the stimuli presented or response obtained. An application of the operant notions to reading behavior would require more rigour in specification of the stimulus and response relationships as well as a more direct demonstration of the reinforcing stimulus. In spite of these objections, the use of S-R notation seems justified in that what is being described is in fact the stimulus and response relationships as they occurred in the program. An abstraction of these relationships to S-R terms should make the details of the sequence clear as well as offering some general programing rules. These rules, empirically derived, have served in the generation of this program and may well be used in the generation of other programs or teaching procedures. For example, the structure of an echo is useful not only in teaching letter sounds, but also in generally naming objects and attributes over a wide range of content.

Echo Rule

Teacher: "This is_____, you say_____."

Student: says "______."

This rule generates the following paradigm in S-R notation:

S ⟶	R
Machine shows (____) "This is (____) You say (____)"	Child says "(____)"

Where S is a general term referring to all of the auditory and visual material which is logically relevant to the response, the arrow (⟶) denotes the phrase "is followed by" and R is used to denote the response. Any object, name or attribute can be substituted for the place holder (____).

S ⟶	R
- picture of two rabbits - Machine says "here are two rabbits. You say, two rabbits."	Child says, "two rabbits."

At several places in the program the echo structure is used to teach different content:

1. Machine Parts:

S ⟶	R
— Photo of typewriter — "This is a picture of your typewriter, say typewriter."	Child says "typewriter."

2. Single letter sounds:

S ⟶	R
-m- "The sound this letter makes is mm, say mm."	Child says, "mm"

3. Unitary response to two letters:

$S \longrightarrow$	R
-mo- "This is mo, say mo."	Child says, "mo."

The rule for teaching visual matching behavior is similar to an echo in that the model to guide the child's correctness is immediately provided. Unlike the echo, the model remains available during the child's response.

Matching Rule

$S \longrightarrow$	R
"Here is my letter. -m- Point to the letter on your button that's just like mine."	Child points to m button.

The visual stimulus (letter m) remains available while the child searches for the same letter-button. Again, the matching rule can be used to teach a variety of content.

$S^1 \longrightarrow$	R^1	$S^2 \longrightarrow$	R^2
"Look down at your typewriter, Watch, I'll show you what I mean."	Child looks and listens.	-photo of typewriter- Here is a picture of your typewriter. Now do you see it?	Child looks at photo, then looks down at typewriter in front of him.

The matching rule in the above example, $(S^2 \longrightarrow R^2)$, is used as feedback for the instruction in the first unit $(S^1 \longrightarrow R^1)$.

The S-R paradigms which follow are rules by which increasingly complex responses are taught in the program. The rules are actually combinations of two or more, simpler S-R units. Paradigm No. 4 combines four units: first, a pointing response; second, a confirmation or revising response; third, a pressing response; and fourth, a confirmation unit referring to the existing state of the typewriter key. The final S-R unit in this chain is the feedback for the pressing response. If the button is locked when the child presses, this is essentially negative corrective feedback telling the child "not that one, try again." The earlier findings of this project, that this type of feedback produced little in terms of learning behavior, led to the development of the first two units of this chain. The strategic paradigm here is the second unit which provides positive corrective feedback. If the child points to the wrong letter, the feedback unit which follows gives him additional information to correct his pointing response. A few seconds later the child is given an opportunity to use this feedback by means of a pressing response. The feedback unit serves a controlling function for the revision of an incorrect pointing response. The response term for the final unit is enclosed in parentheses to denote that this response is inferred rather than directly observable.

Indicating a letter image in response to its sound is a low level of skill complexity, especially when the choice is limited to two or three letters, in comparison with the oral constructed response, where the child must first look at a letter image, organize his own vocal capability, and form or construct the sound himself. At this higher level the child is presented with a letter image and must say the sound associated with that image. An example of this response form is shown in paradigm No. 10. In the second unit of this paradigm the positive corrective feedback is simply an auditory presentation of the correct oral response. The response term in the second unit is not in parentheses since the revision of errors evidenced in the third unit is an observable result of this response. However, the response term in the final feedback unit is enclosed in parentheses as an unobservable response. It is important to note that the echo rule (paradigm 6) and the matching rule (paradigm 2) are lower levels of skill complexity than the oral-constructed response (paradigm 10). All of the paradigms are presented in an order which reflects their comparative level of skill complexity, from simple echoes and matches to higher level indicating and construction responses. Success at one level is predicated on success at lower or preceding levles.

INSTRUCTIONAL PARADIGMS

Skill Level No. & Name								
1 Machine Working Skills	S → (photo of typewriter button) "Here's a picture of a button. Look"	R Child looks down at keyboard	S → (photo of finger pointing to button) "Point to your button"	R Child points to button	S → (photo of finger pressing button) "Press the button"	R child presses	S → button yields to pressure	R (child confirms response)
2 Letter Matching	S → -p- "Point to the letter on your button just like the one in my picture"	R child points to p button	S → -p- "Press the button with this letter on it"	R Child presses p button	S → button yields to pressure	R (child confirms response)		
3 Mnemonic Indicating with Matching Support	S → "Point to o, the round letter"	R child points to one of several buttons	S → -o-	R child confirms or revises choice	S → "Press o"	R child presses o button	S → button yields to pressure	R (child confirms response)
4 Abstract Indicating with Mnemonic Support	S → "Point to o"	R child points to one of several buttons	S → "O is the round letter"	R child confirms or revises choice	S → "Press o"	R child presses o button	S → button yields to pressure	R (child confirms response)

Skill Level No. & Name								
5 CRITERION Abstract Indicating	S → "Press o"	R child presses o	S → button yields to pressure	R child confirms response				
6 Echo	S → -m- "This is mm, say mm"	R child says "mm"						
7 Oral Construction with Echo Support	S → -o- "This is o, say o"	R child says o	S → -o- "Say the sound"	R child says o	S → "It's o"	R (child confirms response)		
8 Construction with Indicating support	S → "Press mm"	R child presses m button	S → -m- "Say the sound"	R child says "mm"	S → -m- "It's m"	R (child confirms response)		
9 Oral Construction with Oral Selection Support	S → -m- "Is this mm or o?"	R child selects and reproduces one of the sounds	S → "It's mm"	R child confirms or revises response	S → "Say the sound"	R "It's mm"	S → "It's m"	R (child confirms response)
10 Oral Construction	S → -m- "Say the sound"	R child produces or doesn't produce a sound	S → "It's mm"	R child listens to feedback	S → -m- "Say the sound"	R child says "It's mm"	S → -m- "It's m"	R (child confirms response)

Skill Level No. & Name								
11 CRITERION Oral Construction	S → -m- "Say the sound"	R "mm"	S → -m- "It's m"	R (child confirms response)				
12 Unitary Indicating (bigrams) with single sound support	S → "Point to mo"	R child points to one of several buttons	S → "Mo is the one with m and o"	R confirms or revises choice	S → "Press mo"	R presses mo button	S → button yields to pressure	R (child confirms response)
13 CRITERION Unitary Indicating	S → "Press mo"	R child presses mo	S → button yields to pressure	R (child confirms response)				
14 Unitary Echo	S → -mo- "This is mo, say mo"	R child says "mo"						
15 Unitary Oral Construction with Echo Support	S → -mo- "Say mo"	R child says "mo"	S → "Say the sound" -mo-	R child says "mo"	S → "It's mo"	R (child confirms response)		
16 Unitary Oral Construction with Unitary Indication Support	S → "Press mo"	R child presses mo	S → "Say the sound" -mo-	R child says "mo"	S → "It's mo"	R (child confirms response)		

Skill Level No. & Name								
17 Unitary Oral Construction (bigrams) with oral selection support	S -po- "Is this po or mo?"	→ R child produces one of the sounds	S -po- "It's po"	→ R child confirms response	S -po- "Say the sound"	→ R child says "po"	S -po- "It's po"	→ R (child confirms response)
18 CRITERION Unitary Oral Construction	S -mo- "Say the sound"	→ R child says "mo"	S -mo- "It's mo"	→ R (child confirms response)				
19 Oral Response to Letter Position with Visual Support	S -mo- "The arrow is pointing to the first (or last) letter. Say the sound the first (or last) letter makes"	→ R child says "m" (or o)	S -mo- "It's m." (or o)	→ R (child confirms response)				
20 Oral Ordered Construction	S -so- "Say the sound of the first letter"	→ R child says "ss"	S -so- "It's ss. Now say the sound of the last letter"	→ R child says "o"	S -so- "It's o"	→ R (child confirms response)		
21 Oral Ordered Construction (Letter Order)	S -mo- "Say the sound of the first letter and then the last letter"	→ R child says "m" then "o"	S -mo- "It's m, o"	→ R (child confirms response)				

Skill Level No. & Name	S	R	S	R	S	R	S	R
22 Auditory Echo	"Say m"	"m"	"Say a"	"a"	"Say ma"	"ma"		
23 Auditory Echo Chain	"Say m, a, ma"	"m, a, ma"						
24 Auditory Blend	"m, a, say both sounds together"	"ma"	"It's ma"	Listens to feedback	"m, a"	"ma"		
25 Blending Response Chain with Ordered Oral Con-Struction Support	-mo- "Say the sound of the first letter and then the last letter"	child says "m" then "o"	-mo- "It's m, o"	child confirms response	-mo- "Now say the first, the last, and both together"	child says "m, o, mo"	-mo- "m, o, mo"	child confirms response)
26 Visual Blend	-ma- "Say the sound of the first letter then the last letter"	"m,a"	-ma- "m,a, now say both sounds together"	"ma"	-ma- "It's ma. Say the sound of the first letter, the last letter and then both sounds together"	"m, a, ma"		

Skill Level No. & Name	S →	R	S →	R	S →	R	S →	R
27 Perceptual Set with Visual Support	-ma t- "Say the sound of the first two letters"	child says "ma"	-ma t- "It's ma"	child confirms response	-ma t- "now say the sound of the last letter"	child says "t"	-ma t- "It's t"	child confirms response
28 Perceptual Set	-mat- "Say the sound of the first two letters"	"ma"	-mat- "It's ma"	child confirms response	-mat- "Say the sound of the last letter"	"t"	-mat- "It's t"	child confirms response
	-mat- "Now say the sound of the first two, and then the last one"	child says "ma, t"	"It's ma, t:	(child confirms response)				
29 Auditory Echo	"Say mo"	"mo"	"Say m"	"m"	"Say mom"	"mom"		
30 Auditory Echo Chain	"Say mo, m, mom"	"mo, m, mom"	"Say mo, m, mom"	"mo, m, mom"				
31 Auditory Blend	"mo, m"	"mom"	"mom"	child confirms response	"mo, m"	"mom"		

Skill Level No. & Name	S	R	S	R	S	R	S	R
32 Visual Blending Chain with Perceptual Set Support	-mom- "Say the sound of the first two letters, and then the last letter"	"mo, m"	-mom- "It's mo, m"	child confirms response	-mom- "Say the sound of the first two, last one and then say the word"	"mo, m mom"	"mo, m, mom"	(child confirms response)
33 Visual Blend with Blending Chain Support	-mom- "Say the sound of the first two letters, the last letter, then say the word"	child says "mo,m, mom"	-mom- "mo, m, mom"	child confirms response	-mom- "Now, just say the word"	"mom"	-mom- "It's mom"	(child confirms response)
34 CRITERION Visual Blend	-mom- "Say the word"	"mom"	-mom- "It's mom"	(child confirms response)				

Appendix E. A Report on Machine Failures and Down Time for a Six-Month Period

During the period September, 1967 through February, 1968, detailed records were kept on the machine failures which occurred. All major failures are reported in Tables 1 and 2 which show a month by month breakdown for each of the two machines used. A major failure is defined as any failure which prevented the use of the machine and required the presence of a company technician to restore the machine function. The number of days for each month was based upon the number of school days contained within that month. For purposes of reporting machine down time (the amount of time the machine was out of service for any specific failure) the number of days was multiplied by a factor of six hours per school day, yielding the total number of hours the machine was available for use with the children. This manipulation is represented in the column tabled "Total Time."

The total amount of time the machine was out of service for each month is recorded in the column labeled "Down Time." These entries are based on the six-hour school day. That is, if the machine failed at 1:00 on Monday and was restored at 12:00 on Wednesday, the down time would be 11 hours: 2 hours on Monday, 6 on Tuesday, and 3 on Wednesday. The percent down time reflects the percentage of the time the machine was out of service relative to the total amount of time it should have been available for use with the children.

The remaining columns show a breakdown for the number and types of failures which occurred. Keyboard failures were generally characterized by a complete locking of the keyboard so that no key could be depressed. Keyvoice failures usually reflect a fading of the keyvoice message. Failures in the audio function generally consisted of faded sound or the skipping of the sequential order of the tracks. Sometimes the machine persistently produced operations which differed from the encoded function. These failures are reflected in the column labeled "Code Reading." The projector failures ranged from a failure to move from one slide to the next, to a general mechanical breakdown. On several occasions the card stuck on a particular line or failed to move to the next line after completing a given line. These failures are reported in the "Card Lift" column. Other failures which are reported in the miscellaneous column reflect general erratic behavior from the machine, such as loud grinding noises or the repetition of audio messages over and over.

In addition to the major failures detailed in the tables, there were a number of minor failures encountered throughout the six-month period. A minor failure is defined as any malfunction sufficiently disruptive to interrupt the progress of the lesson, but which did not require the presence of a company technician to restore the machine functioning. These malfunctions included items like slide projector jams, typewriter carriage locking, the machine reading incorrect codes in the event sequence, and others. These minor failures were frequently symptomatic of a pending major failure but did not occur with sufficient predictability to justify investigation by the company technicians. There were 27 recorded instances of minor failures for machine #1 and 35 for machine #2 during the reported six-month period.

Table 1

Machine Failures and Down Time for Machine #1 for the Period

September 1, 1967 through February 28, 1968

		Time			Types of Failure							
Month	Number of Days	Total Time	Down Time	Percent Down Time	Key-board	Key-voice	Audio Function	Code Reading	Projector	Card Lift	Misc.	Total
September	20	120 hours	6.7 hours	5.6%	2	-	1	1	-	1	-	5
October	20	120	29.25	24.4%	5	-	-	-	-	-	-	5
November	16	96	7.5	7.80%	-	-	-	-	-	1	1	2
December	18	108	38.25	35.40%	-	-	3	1	1	-	1	6
January	20	120	22.75	18.0%	-	1	1	1	1	-	2	6
February	16	96	36.0	37.5%	-	1	-	-	-	-	-	1
Totals	110	660	140.5	21.3%	7	2	4	3	2	2	4	25

Table 2

Machine Failures and Down Time for Machine #2 for the Period

September 1, 1967 through February 28, 1968

		Time			Types of Failure							
Month	Number of Days	Total Time	Down Time	Percent Down Time	Key-board	Key-voice	Audio Function	Code Reading	Projector	Card Lift	Misc.	Total
September	20	120	14 hours	11.67%	-	-	-	-	1	-	-	1
October	20	120	21.25	17.71%	1	-	-	1	-	-	3	5
November	16	96	10	10.42%	-	1	-	2	-	1	-	4
December	18	108	5	4.63%	-	-	-	1	-	1	1	3
January	20	120	5	4.17%	-	-	-	1	-	1	-	2
February	16	96	4	4.16%	1	-	-	-	-	-	-	1
Totals	110	660	59.25	9.0%	2	1	-	5	1	3	4	16

Appendix F. Acquisition of Pre-reading Skills Using a "Talking Typewriter" : A Dialogue

Q: Is there any particular significance in your project's being located in an elementary school?

A: Yes, we are studying the beginning reading skills of children who have not yet entered first grade. We are located in an elementary school so that we can work with five-year olds.

Q: Are you concerned with all the five-year olds in the school?

A: We are concerned with all of the five-year olds, but this project is directed toward those five-year olds who come from socially and economically disadvantaged backgrounds. While the school we work in is located in Harlem, that does not mean that all the children in the school are from disadvantaged backgrounds. This is especially true because some of the children in this school live in a middle-income cooperative housing project.

Q: Why do you make this distinction between advantaged and disadvantaged backgrounds?

A: Descriptive statistical studies reveal that large proportions of children from low socio-economic backgrounds fail to learn to read well. Recent research indicates that children from advantaged backgrounds enter school equipped with many skills relevant to beginning reading. These skills are ones that have been carefully taught at home. By working with children who have not been taught these skills at home, we are discovering much about the ways these skills are learned. From a research point of view, this means that we are really learning about the acquisition of beginning reading skills.

Q: Shouldn't five-year olds, and especially those from disadvantaged backgrounds, be given more general readiness experiences instead of being taught to read?

A: Your question contains two misleading implications. First, in their kindergarten classes the children are being given those experiences that constitute general readiness for reading. The approach employed in our project does not at all deny the value of varied readiness experiences for young children, both as preparation for reading and for school in general. Second, the aim of our project is not to teach children to read but rather to research the acquisition of a variety of clearly defined pre-reading skills. Through this research, we hope to understand the ways in which children become prepared for formal reading instruction.

Q: You just said that this is a research project. Is this just another research project that increases our knowledge about the problem rather than doing something about it?

A: We hope not. Our project is organized so that increased knowledge of the problem can be immediately utilized in developing a lesson or sequence of lessons which actually teach what they are designed to teach. When lessons fail, we revise them until they teach and, if necessary, we conduct a more formal research study to clarify the problems involved.

Usually such a project would be called a research and development project. But because our project has at its heart the development of these teaching sequences, it can more accurately be described as a research in development project.

Our researching involves tracking the ways in which young children learn and fail to learn the visual and auditory skills basic to reading. For example, at the very outset of our work we encountered the following problem: Some children had considerable difficulty mastering the keyboard when faced with all the letters. Not only was the child faced with a new learning tool, the ERE, but also with a complex set of graphic symbols.

In this instance, we conducted a formal study to measure the effects of keyboard complexity (or the number of keys on the keyboard) and the amount of time required for a child to learn to match all 26 letters of the alphabet. In this study, one group of children began by matching only a few different letters--The ERE would indicate which letter to match and the child could choose the correct key from 6 keys, with the remaining keys covered up. Over a period of several days, all the keys were exposed. Another group of children were faced with all 26 letters from the beginning of training. This study indicated in a systematic way that teaching a child the behavior of letter-matching with a simplified task enabled the child to master the more complex task with a minimum of frustration and in much shorter time than would otherwise have been possible. We were immediately able to utilize these findings by designing programs which employed only a few letters.

It might seem that we could have reached the same conclusions without conducting a formal study, and this is quite possible. Nevertheless, the usefulness of systematic research lies in the generalizability of its results. We have made many specific applications of the general conclusions which came from this study, namely, the importance of beginning with a simplified task. With some problems we encounter we will continue to conduct formal studies such as this to validate our programing methods. With other problems such format studies are not necessary. Enough is learned from the careful observation of a small number of children to determine that revisions are needed and what types might prove appropriate.

Q: If your aim is to study the skill-acquisition process, why don't you teach these skills directly to the children yourself and observe what happens as you teach, instead of using fancy instruments like the ERE?

A: There are three major reasons for using an instrument such as the ERE: (1) the reproducibility of lessons, (2) the increased accuracy in the observation of learning, and (3) the discipline of programing.

So far as the reproducibility of lessons is concerned, lessons can be tested with different children and we know they are the same lessons. We have, in the lessons, arranged for all the events that do the teaching. When a lesson is successful, we know that the reasons for success are contained within the lesson itself, and are not the result of extraneous factors which are often present in situations where children interact with adults.

The result is that our knowledge of the skill-acquisition process is as free as possible of human variations, thus assuring us that we indeed have identified the underlying process and not just one particular teacher's version of that process. If we let individual teachers do the skill teaching, for research purposes we really couldn't separate the teacher's performance from the process she used. Consequently, we wouldn't know where to accurately pinpoint lesson success or failure.

Furthermore, the lessons provide a permanent record of the events which do or do not make for adequate learning. When successful lessons have been constructed, it is possible to communicate to others exactly what does the teaching. Reproducibility is important because you can study lessons during the developmental stages, and the resultant lessons can be passed on to others.

Closely related to the reproducibility of lessons is our second reason for using the ERE: the increased accuracy with which we can observe the learning process. Accuracy is lost when we have to both teach and observe simultaneously. Having a device which can carry out direct instruction enables us to assume highly observant and objective attitudes. This is crucial to our task.

The last reason, that of the discipline required to program lessons successfully, is one whose importance we have recognized more and more. Many teachers-turned-programer have commented on the difficulties and eventually the insights and clarifications, which result from actually writing out sequences to teach subject matter which, on a more or less intuitive basis, they have been "teaching successfully" for years. This experience is multiplied when the lessons you construct are for a "talking typewriter" used by a preliterate child from a disadvantaged background.

In our project, the process begins with specifying the objective of the lesson. Once the initial program has been written, everyone can raise questions as to the relevance, conciseness, and assumptions of the lessons. Not only must lessons get by the "murderers' row" of the critics Caudle, Gotkin, McSweeney and Richardson, but they must pass the higher court of the children.

Q: You keep using the word "skill" and referring to lessons that teach "pre-reading skills." What, exactly, is a pre-reading skill?

A: You really want to pin us down, don't you? Pre-reading skills are merely consistent ways of responding to the elements of spoken or written language.

We have roughly categorized these skills into perceptual and conceptual skills. *Perceptual* skills primarily include abilities such as visual and auditory discrimination, that is, seeing and hearing differences and/or similarities. The ability to perceive that "Q" is different from "O" or "C" is a visual pre-reading skill. It is not necessarily a *reading* skill since the skill can be taught when the letters "Q" and "O" are, so far as the child is concerned, merely funny looking lines rather than "alphabet letters." The important point is that the use of this specific skill, while not in itself constituting the act of reading, *will* be included in the act of reading when combined with other skills.

Conceptual skills are a little more difficult to define. Primarily, these skills are concerned with responding correctly to the ways in which the elements of written and spoken language are organized and coordinated. The concept of order is a particularly important skill, since all language is ordered. Written language is ordered from left to right, and spoken language is ordered in time. The child must acquire numerous concepts related to order: with written language he must realize that "ton," "not," and "otn" must be responded to differently--while the child might *see* these as different looking groups, he may still *treat* them as being the same because they all include the same letter-shapes. Thus, he would have the perceptual skill, that is, seeing that the letter groups were not identical in appearance because the elements were ordered differently. However, he would lack the *conceptual* skill of order, that is, the realization that the ordering of the elements is important in differentiating the sequences from one another.

There are many other conceptual skills. In the auditory realm, an important skill is the ability of a child to attend to and identify the initial sound in spoken (and later printed) words. Notice that this skill requires attention to the *first* sound, so that the child must have had some previous experience with the skill of order, so that he can solve the problem. Another example of a conceptual pre-reading skill is the concept that the smallest units of written language, letters, can be organized into larger units by means of spaces between sequences of letters. Possession of this concept in turn facilitates the ability of the child to perceive such a *sequence* of letters as a discrete unit in itself, rather than as a series of smaller discrete units. In a mature reader, this skill is refined, unified, automatic, and almost unconscious. Mastery of this skill quite likely lays the groundwork for the development of much more complex reading skills in which the units become much larger: phrases, even whole sentences.

Pre-reading skills provide the child with consistent techniques for processing information, techniques whose mastery will later enable the child to attend to the *meaning* of written language without being hindered by the *structural* organization and composition of the language, since responses to the structural aspects will have become virtually automatic.

Q. Look, my attitudes are beginning to change about all this, but how could local school systems really afford to buy this equipment and hire people to run it? I mean, is this possible?

A: The question of economic feasibility is frequently asked. We will offer some comments on this issue, but wish to make clear that our research and the purpose of this demonstration are not directed toward adjudicating economic issues.

Equipment like the ERE is expensive. Once its instructional potential has been more clearly determined through research, shcool administrators will be better able to relate costs to the aims, needs and resources of local school systems. In the last analysis, these decisions will be made by school boards and school administrators, as are other budgetary decisions.

We would like to suggest that such decisions will be influenced in the future by two factors, Federal funding and changing technology. Our job is to contribute data and knowledge which will more clearly define the instructional issues and problems. Also, we will evaluate the effectiveness of machine instruction.

Q: Now you've touched on something that's been bothering me--the evaluation of the effectiveness of the whole sequence of lessons. How will you do this?

A: Before answering this question, it is necessary to point out that our project involves development of programs which, although designed for the ERE, will "be translated" into sequences appropriate for use in the classroom. Thus, our evaluation will be concerned with two factors: (1) a comparison of machine instruction and classroom instruction, using the lesson sequence; and (2) the evaluation of the actual effectiveness of the lesson sequence itself as preparation for reading.

In order to compare machine instruction and teacher instruction, a formal research study will be conducted in which there will be four experimental treatments, which will differ according to the way in which the lesson sequence is taught. All the children who participate in the study will be attending kindergarten classes, and will be carefully pre-tested so that they will be roughly equivalent in terms of the skills which they already have, before receiving instruction. Of these children, one group will receive instruction in pre-reading skills entirely with the ERE, and will receive no such instruction in the classroom. A second group of children will receive similarly organized instruction which is given by the kindergarten teacher in the classroom. A third group will receive a mixed form of instruction, with some machine instruction and some teacher instruction. A fourth group will receive no special instruction in pre-reading skills, other than the instruction which is contained within the regular kindergarten program.

We will use a series of post-tests to see how these groups differ in the degree to which they acquire pre-reading skills. Also, throughout the period of instruction, we will observe the amount of time required to complete various parts of the lesson sequence, the number of errors made, and the difficulties or frustrations which the children experience. With such observations as these, we will be able to make a more realistic appraisal of the appropriateness and effectiveness of the lesson sequence, rather than limiting our evaluation to test scores and statistics.

However, this is not all. We are, in our project, only concerned with preparing children to learn to read. To really find out whether we've succeeded in this, we must wait until the children receive some formal reading instruction and then compare the groups again. Thus, our plans call for administering standardized reading achievement tests after the children have completed the first grade. At this time we should have answers to these questions:

1. Does training in pre-reading skills increase the effectiveness of formal reading instruction?
2. How effective is an automated teaching machine in supplying these skills?